# BIG THICKET NATIONAL PRESERVE: WATER QUALITY REPORT 1984 – 1986



WATER RESOURCES REPORT 87–2



WATER RESOURCES DIVISION
NATIONAL PARK SERVICE
FORT COLLINS, COLORADO 80521

BIG THICKET NATIONAL PRESERVE:

WATER QUALITY REPORT 1984 - 1986

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## ABSTRACT

The Big Thicket National Preserve in southeastern Texas contains diverse water resources, including the lower Neches River, several major streams and smaller tributaries, and extensive floodplain forest, baygall, and cypress sloughs. Present land-use activities within the watershed of Big Thicket National Preserve such as oil and gas operations, timber harvesting, and residential development may adversely influence the quality of the water entering the preserve.

Previous to 1984, the National Park Service relied on external organizations for data on water quality conditions in Big Thicket National Preserve. Studies were conducted by Lamar University from the mid-1970s to early 1980s which provided in-depth information on water quality in several Big Thicket streams. Also, the U.S. Geological Survey monitors water quality at streams in and around the preserve and is available for park service use.

In November 1984, the National Park Service initiated a water quality monitoring program in the Big Thicket National Preserve to evaluate stream water quality conditions and to detect changes in water quality resulting from external sources and surrounding land use. Samples were collected at 25 sampling sites and were analyzed for 15 parameters, including indicators of oil and gas pollution, sewage discharge, and watershed disturbances. This document summarizes the first two years of data collected in the National Park Service monitoring program (November 1984 to November 1986) and compares the results of these monitoring efforts to information gathered from the earlier studies and monitoring activities.

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TABLE OF CONTENTS


| | Page |
|---|---|
| Abstract | i |
| Acknowledgments | ii |
| List of Figures | v |
| List of Tables | viii |
| Introduction | 1 |
| Description of the Area | 3 |
| Geology and physiography | 3 |
| Soils | 3 |
| Vegetation | 3 |
| Climate and hydrology | 4 |
| Water Quality Impacts | 5 |
| Oil and gas production | 5 |
| Timber harvesting | 6 |
| Agricultural activities | 6 |
| Rural and urban areas | 6 |
| Monitoring Program | 8 |
| Sampling Site Selection | 9 |
| Water Quality Parameters | 12 |
| Sampling Schedule | 12 |
| Results | 19 |
| Precipitation and Discharge | 19 |
| Relationship between rainfall and discharge | 25 |
| Category 1 Streams | 27 |
| Stream Descriptions | 27 |
| Beech Creek | 27 |
| Big Sandy Creek | 27 |
| Turkey Creek | 29 |
| Black Creek | 29 |
| Water Quality Summary | 30 |
| Data Comparisons: U.S. Geological Survey Water Quality Stations | 43 |
| Category 2 Streams | 43 |
| Stream Descriptions | 44 |
| Menard Creek | 44 |
| Little Pine Island Bayou-Pine Island Bayou | 44 |
| Water Quality Summary | 45 |
| Data Comparisons: U.S. Geological Survey Water Quality Stations | 58 |
| Category 3 Stream | 59 |
| Stream Description | 60 |
| Water Quality Summary | 62 |
| Discussion | 65 |
| Comparison with Previous Studies | 65 |
| Conclusions and Recommendations | 76 |

Page

Literature Cited . . . . . . . . . . . . . . . . . . . . . . . . . . 79

Appendices
A: Big Thicket National Preserve, Water Quality Monitoring Data: November 1984 - November 1986
B: U.S. Geological Survey Water Quality Monitoring Data for Stations in the Vicinity of Big Thicket National Preserve, November 1984 - November 1986

LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1 | Management units of Big Thicket National Preserve, Texas . . | 2 |
| 2 | Location of NPS monitoring sites in Big Thicket National Preserve, Texas . . . . . . . . . . . . . . . . . . . . . . | 10 |
| 3 | Sampling schedule (1984-1986) for Category 1 water quality monitoring sites in Big Thicket National Preserve, Texas . . | 16 |
| 4 | Sampling schedule (1984-1986) for Category 2 and 3 water quality monitoring sites in Big Thicket National Preserve, Texas . . . . . . . . . . . . . . . . . . . . . . . . . . | 17 |
| 5 | Location of National Oceanographic and Atmospheric Administration climatological and U.S. Geological Survey gauging stations in and near Big Thicket National Preserve, Texas . . . . . . . . . . . . . . . . . . . . . . . . . . | 20 |
| 6 | Monthly rainfall (November 1984 - November 1986) and period of record (POR) mean monthly rainfall at three National Oceanographic and Atmospheric Administration rainfall stations in the vicinity of Big Thicket National Preserve, Texas . . . . . . . . . . . . . . . . . . . . . . | 22 |
| 7 | Monthly discharge (November 1984 - November 1986) and period of record (POR) mean monthly discharge at four U.S. Geological Survey stations in the vicinity of Big Thicket National Preserve, Texas . . . . . . . . . . . . . . . . . . . | 24 |
| 8 | Locations of monitoring sites on Category 1 streams in Big Thicket National Preserve, Texas . . . . . . . . . . | 28 |
| 9 | Monthly stream water temperatures for Category 1 stream monitoring sites (November 1984 - November 1986) . . . . . . | 31 |
| 10 | Monthly dissolved oxygen concentrations for Category 1 stream monitoring sites (November 1984 - November 1986) . . | 32 |
| 11 | pH medians and ranges for Category 1 stream monitoring sites (November 1984 - November 1986) . . . . . . . . . . . | 33 |
| 12 | Specific conductance medians and ranges for Category 1 stream monitoring sites (November 1984 - November 1986) . . | 35 |
| 13 | Turbidity medians and ranges during low-flow and intermediate/high-flow conditions for Category 1 streams (November 1984 - November 1986) . . . . . . . . . . . . . . | 36 |
| 14 | Chloride median concentrations and ranges for Category 1 stream monitoring sites (November 1984 - November 1986) . . | 37 |

| Figure | | Page |
|---|---|---|
| 15 | Geometric means and ranges for fecal coliform bacteria and fecal streptococcus bacteria for Beech Creek and Big Sandy Creek (November 1984 - November 1986) | 39 |
| 16 | Geometric means and ranges for fecal coliform bacteria and fecal streptococcus bacteria for Black Creek, Turkey Creek, and Village Creek (November 1984 - November 1986) | 40 |
| 17 | Locations of monitoring sites for Category 2 streams in Big Thicket National Preserve, Texas | 46 |
| 18 | Stream water temperatures for Category 2 stream monitoring sites (November 1984 - November 1986) | 47 |
| 19 | Dissolved oxygen concentrations for Category 2 stream monitoring sites (November 1984 - November 1986) | 49 |
| 20 | pH medians and ranges for Category 2 streams (November 1984 - November 1986) | 50 |
| 21 | Specific conductance medians and ranges for Category 2 streams (November 1984 - November 1986) | 51 |
| 22 | Turbidity medians and ranges during low-flow and intermediate/high-flow conditions for Category 2 streams (November 1984 - November 1986) | 53 |
| 23 | Chloride median concentrations and ranges for Category 2 streams (November 1984 - November 1986) | 55 |
| 24 | Geometric means and ranges for fecal coliform bacteria and fecal streptococcus bacteria for Category 2 streams (November 1984 - November 1986) | 56 |
| 25 | Locations of monitoring stations for the Category 3 stream in Big Thicket National Preserve, Texas | 61 |
| 26 | pH, chloride, turbidity, specific conductance, and bacterial monitoring data for USGS station 0804100 (Neches River at Evadale, TX) November 1984 - November 1986 | 63 |
| 27 | Comparison of turbidity data (means and 95% confidence intervals) from previous studies and the present program at Beech Creek, Big Sandy Creek, Turkey Creek, Village Creek, Menard Creek, and Little Pine Island Bayou monitoring sites | 66 |
| 28 | Comparison of pH data from earlier studies with the present program at Menard Creek, Little Pine Island Bayou, Pine Island Bayou, Beech Creek, Big Sandy Creek, Turkey Creek, and Village Creek monitoring sites | 67 |

| Figure | | Page |
|---|---|---|
| 29 | Comparison of specific conductance data (means and 95% confidence intervals) from earlier studies with the present program at Beech Creek and Big Sandy Creek monitoring sites | 69 |
| 30 | Comparison of specific conductance data (means and 95% confidence intervals) from earlier studies with the present program at Turkey Creek, Village Creek, and Menard Creek monitoring sites | 70 |
| 31 | Comparison of specific conductance data (means and 95% confidence intervals) from earlier studies with the present program at Little Pine Island Bayou and Pine Island Bayou monitoring sites | 71 |
| 32 | Comparison of chloride data (means and 95% confidence intervals) from earlier studies with the present program at Beech Creek and Big Sandy Creek monitoring sites | 72 |
| 33 | Comparison of chloride data (means and 95% confidence intervals) from earlier studies with the present program at Turkey Creek, Village Creek, and Menard Creek monitoring sites | 73 |
| 34 | Comparison of chloride data (means and 95% confidence intervals) from earlier studies with the present program at Little Pine Island Bayou and Pine Island Bayou monitoring sites | 74 |
| 35 | Comparison of fecal coliform bacteria data and fecal streptococcus bacteria data from earlier studies with the present program at Big Sandy Creek, Turkey Creek, Village Creek, Menard Creek, Little Pine Island Bayou and Pine Island Bayou monitoring sites | 75 |

LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1 | Water quality monitoring sites in the Big Thicket National Preserve, Texas . . . . . . . . . . . . . . . . . . . . . . | 11 |
| 2 | Field and laboratory parameters for the Big Thicket National Preserve water quality monitoring program . . . . . | 13 |
| 3 | Field and laboratory procedures used to analyze the selected water quality parameters . . . . . . . . . . . . . . | 14 |
| 4 | Texas State Water Quality Standards for stream segments within Big Thicket National Preserve . . . . . . . . . . . . | 15 |
| 5 | Surface water and precipitation stations near Big Thicket National Preserve . . . . . . . . . . . . . . . . . . . . . . | 19 |
| 6 | Annual precipitation for selected National Oceanographic and Atmospheric Administration climatic stations . . . . . . | 21 |
| 7 | Percent differences from the period of record mean annual discharges for water years (WY) 1985 and 1986 . . . . . . . | 25 |
| 8 | Flow volumes (in acre-feet) for the USGS stations in the vicinity of Big Thicket National Preserve during water years (WY) 1985 and 1986 . . . . . . . . . . . . . . . . . . | 25 |
| 9 | Paired National Oceanographic and Atmospheric Administration (NOAA) and U.S. Geological Survey (USGS) stations used in linear regression analysis . . . . . . . . . . . . . . . . . . | 26 |
| 10 | Means and ranges for alkalinity, color, and sulfate in Category 1 streams (November 1984 - November 1986) . . . . . | 41 |
| 11 | Means and ranges for TSS, TDS, and oil and grease in Category 1 streams (November 1984 - November 1986) . . . . . | 42 |
| 12 | Means and ranges for alkalinity, color, total suspended solids (TSS), total dissolved solids (TDS), and sulfate in Category 2 streams (November 1984 - November 1986) . . . . . | 57 |
| 13 | Means and ranges of water quality parameters from the USGS monitoring station 0804100, Neches River at Evadale (1984 - 1986) . . . . . . . . . . . . . . . . . . . . . . | 64 |

# INTRODUCTION

Big Thicket National Preserve was established in October 1974 by Public Law 93-439, in order to "assure the preservation, conservation, and protection of the natural, scenic and recreational values of the Big Thicket area." Big Thicket is a unique area located in a biological transition zone where elements of the eastern hardwood forests, the southwestern deserts, the central prairie grasslands, and the tropical coastal marshes may be found. Twelve management units have been designated in Big Thicket National Preserve (Fig. 1), that comprise diverse vegetative associations ranging from dry upland communities to wet floodplain communities (Harcombe and Marks, 1979). Meandering through these management units are slow-moving streams, bayous, and swamps that make up an important part of this diverse ecosystem.

Most of the waterways flowing through Big Thicket National Preserve begin outside of the preserve's boundaries. Because the National Park Service (NPS) has little control over what type of land uses occur in the watershed upstream and adjacent to the preserve, the NPS Water Resources Division and Big Thicket National Preserve have developed a water quality monitoring program to detect possible impacts that may arise from these external land-use practices (Flora, 1984).

The purpose of this paper is to report the results of the first two years (November 1984 - November 1986) of the Big Thicket water quality monitoring program and to relate the information to previous studies conducted in the preserve. In this way, it is hoped that possible impacts caused by recent land-use activities may be recognized and, ultimately, fully assessed.

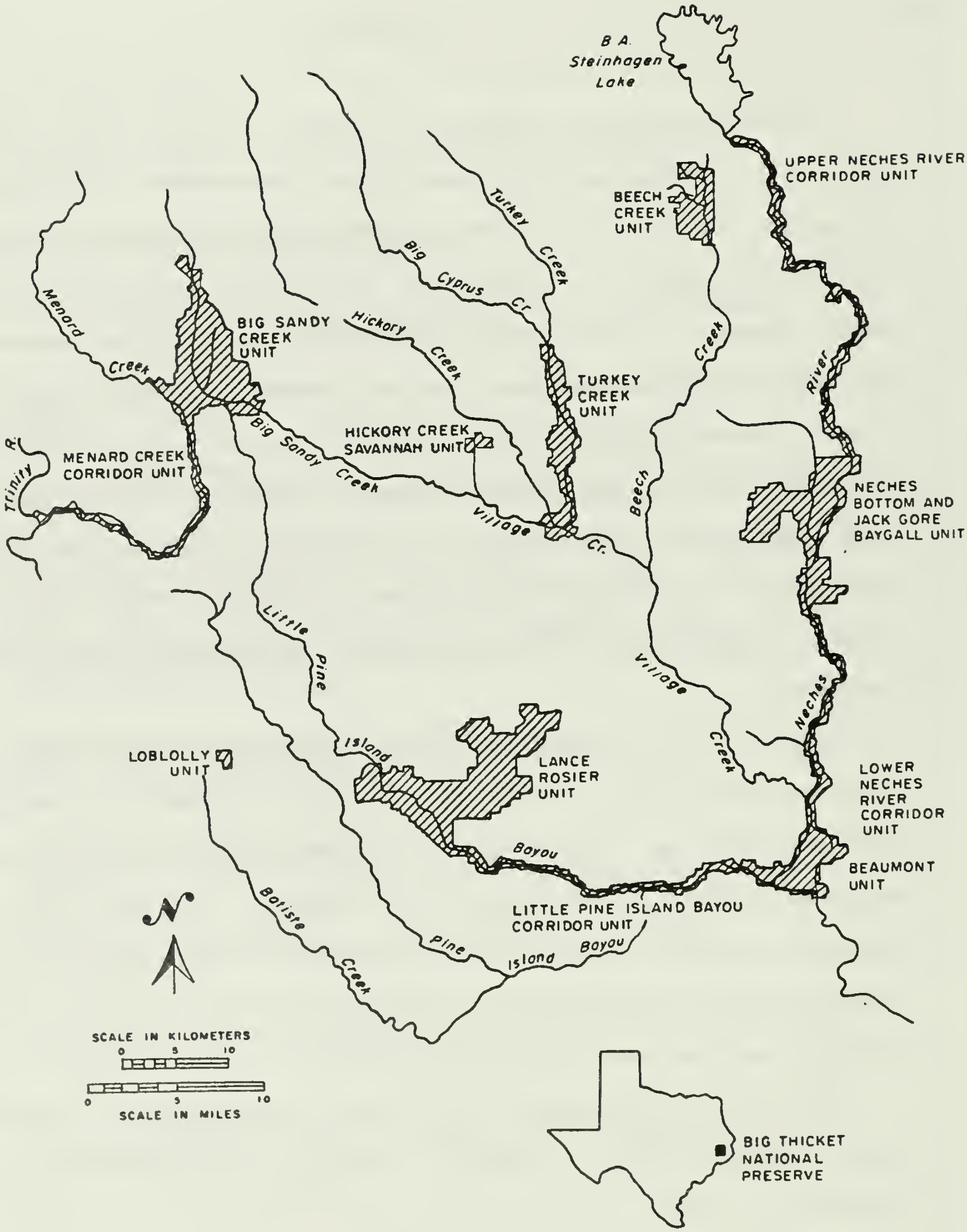



Figure 1. Management units of Big Thicket National Preserve, Texas.

Description of the Area

Big Thicket National Preserve comprises 34,217 hectares (84,550 acres) scattered throughout portions of Hardin, Jasper, Jefferson, Liberty, Orange, Polk, and Tyler counties in southeastern Texas. The management units are generally surrounded by private lands and small communities, with a small section bordering the Alabama-Coushatta Indian Reservation.

Geology and physiography. The Big Thicket region is relatively young geologically and is made up of four major geologic formations. From oldest to youngest, these are the Willis, Bentley, Montgomery, and Beaumont formations. These formations were deposited by alluvial processes during the Pleistocene and Holocene epochs. The hilly topography in the northern sections of Big Thicket is separated from the low, flat, and poorly drained southern areas by the Hockley scarp (USDI, 1976; Watson, 1979). The total elevation change in Big Thicket National Preserve ranges from 365 feet (111 m) at the northwestern tip of the preserve to 5 feet (1.5 m) at the southern end of the Beaumont management unit (Deshotels, 1978).

Soils. Soils found in the hilly, northern section of Big Thicket National Preserve are generally well-drained sandy loams. In the central portion of the preserve, the soils become finer-textured loamy soils of clay, silt, and sand, with interspersed concretions of iron oxide. The lower Big Thicket region is dominated by impermeable clays characterized by poor drainage and a high water table.

Vegetation. The vegetation of the Big Thicket region is often characterized by its great variety of community types per unit area. Vegetation types range from drier, upland communities to wet floodplain associations, indicating that water availability greatly influences the type of vegetation on a site (Harcombe and Marks, 1979).

Harcombe and Marks define four broad vegetation types in Big Thicket as upland, slope, floodplain, and flatland vegetation types. Slope and upland vegetation types occupy the majority of area within Big Thicket National Preserve. Shortleaf and loblolly pine, American beech, southern magnolia, white oak, and southern red oak constitute the principal overstory vegetation in the slope forests. The upland vegetation type is dominated by longleaf pine and bluejack oak. This vegetation type grows on sandier sites and is most commonly found in the hillier northern management units.

Several categories of floodplain vegetation exist. Sweetgum and water oak are the dominant trees in small stream floodplains, bald cypress and water tupelo dominate floodplains near deep sloughs and oxbow lakes, and black tupelo (blackgum) and sweetbay dominate the overstory vegetation where there is a high availability of seepage water. In flatland forests where the soils are heavily textured and have poor drainage characteristics, swamp chestnut oak is the dominant tree species. Standing water is common in these floodplain areas, especially after heavy rains.

Climate and hydrology. Climatic conditions in the Big Thicket region are greatly influenced by the Gulf of Mexico. The summers are warm and humid characterized by frequent thunderstorm activity originating from the gulf. Winters are also wet due to frequent frontal storms moving across the region. Snowfall in the area is rare (USDI, 1976). Tropical storms periodically come ashore, bringing heavy rains and high winds to the Big Thicket region. These storms occur most often between June and October and account for a significant portion of summer rainfall (Harcombe and Marks, 1979).

Flooding occurs frequently in this portion of southeastern Texas due to the large amounts of precipitation and frequent intensive rainfall events. Because of the shallow topographic gradients in the area, the flood events

result in standing pools of water rather than rushing torrents of water sometimes encountered in more mountainous regions. Despite these overbank conditions, the low stream velocities associated with the flood events do not result in significant erosion and sedimentation.

## Water Quality Impacts

Since the land area of Big Thicket National Preserve is divided into many individual, discrete management units (Fig. 1), the potential for water quality impacts from external sources is great. The management units are often narrow corridors, with small buffer areas between the stream and external activities. To compound the problem, no headwaters for major streams flowing through the units are located in any of the units. Because of these conditions, impacts from surrounding and upstream land-use activities often affect water quality. These activities include oil and gas production, timber harvesting, agricultural practices, and sewage treatment plant discharge from communities and septic tank usage from rural homesites.

Oil and gas production. One of the most significant water quality concerns in Big Thicket National Preserve is oil and gas production within and adjacent to preserve boundaries. Every major stream flowing through Big Thicket National Preserve has oil and gas production sites within its watershed, often adjacent to the stream bank. A few large oil storage facilities are located in the region as well, which are capable of discharging effluent into local streams if leaks or spills occur.

Waste products such as oil brines have been discharged into the streams in the past with enough frequency to be a concern. The brine material contains high concentrations of chloride, sulfate, and sodium, and its high specific gravity causes the waste to concentrate in the deeper sections of the channel. These discharges have detrimental effects on aquatic life and

aesthetic values, and are sometimes associated with unpleasant, noxious odors.

Timber harvesting. Several timber harvesting areas exist near Big Thicket National Preserve, sometimes abutting the preserve boundaries. The prevalent form of timber harvesting in this region is clearcutting. All the overstory vegetation is removed first during a clearcutting operation, then six months to one year later, the understory is crushed and burned to prepare for the next tree planting. Large machinery used to harvest the trees can produce ruts in the land in which water may become channelized. The most serious water quality concern resulting from this practice is erosion and sedimentation of channels, especially in the northern units where the topography is hillier and water running over the land has a greater velocity and therefore more energy to transport soil particles.

Agricultural activities. Soil loss and the resultant sedimentation may also occur from agricultural activities. The machinery used for planting and maintaining crops disrupts the soil and may induce erosion, especially if land is plowed to the stream bank wherein the natural buffering vegetation is destroyed. Another water quality concern associated with agricultural practices is the application of pesticides on cropland. The NPS has little knowledge of pesticide use in the Big Thicket region. For proper impact assessment, information is needed on the type and quantity of pesticides that are used and the frequencies of application.

Rural and urban areas. Scattered throughout the Big Thicket region are several small communities and rural homesites. Small sewage treatment plants and septic tank systems provide the waste treatment for these communities. Due to the poor soil conditions and frequent flood events, these waste treatment systems can become overloaded and ineffective, resulting in untreated sewage being discharged into streams. This problem,

coupled with recreational uses in streams of Big Thicket National Preserve, can result in high fecal bacteria levels in the waters, especially after high rainfall events.

## MONITORING PROGRAM

The water quality monitoring program outlined by Flora (1984) was implemented in November 1984 to partially address the water quality issues in Big Thicket National Preserve. The objectives of this program are as follow:

1) Establish background water quality for physical, chemical, and bacterial parameters for significant stream segments flowing through the preserve.

2) Develop antidegradation water quality standards for the various categories of water to be used in the planning and permitting process.

3) Implement a cost-effective and efficient water quality monitoring program capable of detecting major changes in water quality trends.

4) Establish an in-house computer data base of water quality measurements taken within the preserve for retrieval, comparison, and future statistical analysis.

5) Identify research needs to determine the localized impact on water quality of oil and gas exploration and drilling.

The streams of Big Thicket National Preserve were segregated into three categories for monitoring purposes based on their historic water quality conditions, stream-side land uses, and susceptibility to degradation. The streams designated as Category 1 streams have the best water quality of any waters in Big Thicket National Preserve and have the highest priority for protection. Category 1 streams include Big Sandy Creek, Beech Creek, Turkey Creek, Village Creek, and Black Creek. Category 2 waters have exhibited degraded water quality conditions for one or more parameters in past sampling programs. Little Pine Island Bayou, Pine Island Bayou, and Menard Creek are classified as Category 2 streams. Category 3 streams are waters which the NPS has little control over their water quality conditions. Only one stream is classified as a Category 3 stream: the Neches River, from the Upper Neches River Corridor Unit through the Beaumont Unit. The Neches

River is a major drainage of southeastern Texas and is routinely monitored by the U.S. Geological Survey.

## Sampling Site Selection

The selection and location of water quality monitoring sites in Big Thicket National Preserve was based on the previous site selections of Dr. Richard Harrel and his students from Lamar University. Dr. Harrel supervised numerous studies in the Big Thicket region (Harrel, 1976, 1977; Harrel and Bass, 1979; Harrel and Commander, 1980; Harrel and Darville, 1978; Harrel and Newberry, 1981; Kost, 1977) designed to monitor water quality and biological conditions of Big Thicket streams. By using many of Harrel's monitoring sites, the NPS has inherited a comprehensive water quality data base with which to compare their results (Flora et al., 1985; Hughes et al., 1986).

For each Category of stream, sampling sites were located as follows:

- Sites were usually selected where the stream entered a Big Thicket National Preserve unit to determine their water quality conditions upon entering the preserve.

- Sites were located upstream and downstream of human impacts such as timber harvesting, oil and gas production, and agricultural and urban developments to assess the influence of these activities on water quality.

- Sites were located downstream of major tributaries to detect water quality changes due to inflow from the tributary areas.

- Sites also were located where access to the site was adequate to make sampling efficient and cost-effective.

Using these criteria, 13 monitoring sites were selected on Category 1 streams, 7 sites on Category 2 streams, and 5 sites on the Category 3 stream (Fig. 2 and Table 1). Even though access to each site was carefully considered, deteriorating road conditions during heavy rains made some sites inaccessible at certain times of the year. This occurs most frequently for sites located in the eastern parts of Big Thicket, near the Neches River.

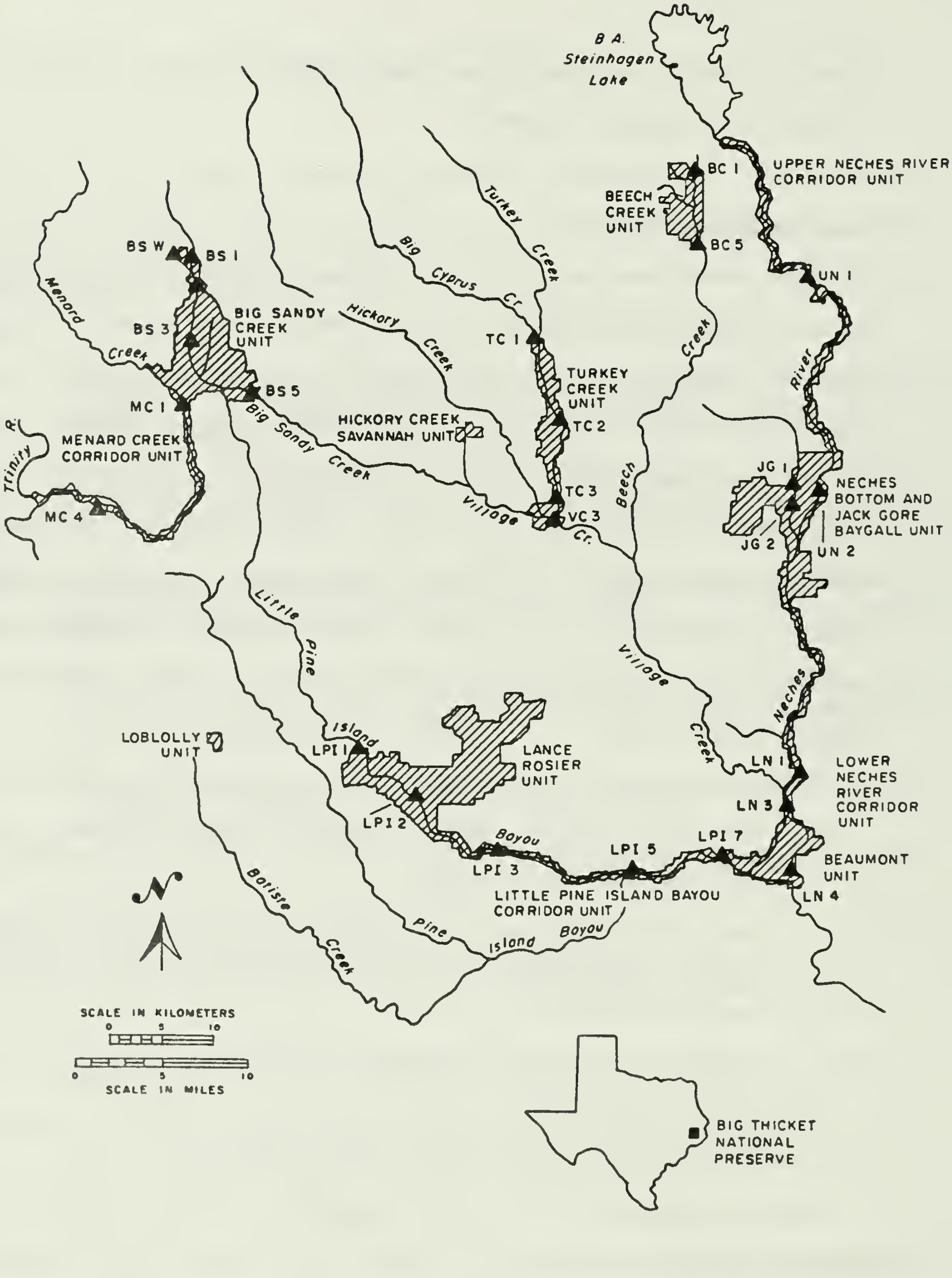



Figure 2. Location of NPS monitoring sites in Big Thicket National Preserve, Texas.

Table 1. Water quality monitoring sites in the Big Thicket National Preserve, TX (Flora, 1984).

**Category 1 Streams**

| | |
|---|---|
| Big Sandy Unit (Big Sandy Creek) | Turkey Creek Unit (Turkey Creek, Village Creek) |
| BS-1<br>BS-2<br>BS-3<br>BS-5<br>BS-W | TC-1<br>TC-2<br>TC-3<br>VC-3 |
| Beech Creek Unit (Beech Creek) | Neches Bottom and Jack Gore Baygall Unit (Black Creek) |
| BC-1<br>BC-5 | JG-1<br>JG-2 |

**Category 2 Streams**

| | |
|---|---|
| Lance Rosier Unit (Little Pine Island Bayou) | Little Pine Island Bayou Corridor Unit (Little Pine Island Bayou, Pine Island Bayou) |
| LPI-1<br>LPI-2 | LPI-3<br>LPI-5<br>LPI-7 |
| Menard Creek Corridor Unit (Menard Creek) | |
| MC-1<br>MC-4 | |

**Category 3 Stream**

| | |
|---|---|
| Upper Neches River Corridor Unit (Neches River) | Lower Neches River Corridor Unit/Beaumont Unit (Neches River) |
| UN-1<br>UN-2 | LN-1<br>LN-3<br>LN-4 |

Water Quality Parameters

The water quality parameters used in the Big Thicket National Preserve monitoring program (Table 2) were selected on the basis of which parameters best identified pollution resulting from land uses in and around the preserve and available funding for the program. The concentrations or values of the selected parameters indicate the influence specific land uses are having on water quality within a stream.

Field parameters are analyzed at each monitoring site by Big Thicket National Preserve personnel, and samples requiring laboratory analysis are delivered to the Trinity River Authority (TRA) Laboratory in Livingston, TX. Analytical procedures utilized in the analysis of field and laboratory constituents are presented in Table 3.

Texas Stream Standards presented in Table 4, summarize stream water quality criteria for specific stream segments within Big Thicket National Preserve (Texas Water Commission, 1986). These are the only stream segments within Big Thicket that have specific stream water quality criteria, although the other waters of Big Thicket may be protected by the following antidegradation statement:

> ... Additionally, no degradation shall be allowed in higher quality waters within or adjacent to national parks and wildlife refuges, wild and scenic rivers designated by law, or other waters of exceptional recreational or ecological significance designated by law if the commission determines that such degradation would significantly impair water quality necessary to protect and maintain the established purpose of such waters (Texas Water Commission, 1986, p.1).

Sampling Schedule

Sampling frequency differs for each stream depending on the particular stream's classification. Figures 3 and 4 outline the sampling schedule for each monitoring site from the beginning of the program through November 1986. Streams classified as Category 1 have the highest priority for

Table 2. Field and laboratory parameters for the Big Thicket National Preserve water quality monitoring program.

| Parameter | Rationale |
|---|---|
| **Field parameters** | |
| temperature | suitability of habitat for fish species |
| specific conductance | oil field brines, sewage treatment plant effluent |
| turbidity | erosion |
| pH | aquatic life |
| dissolved oxygen | aquatic life, organic loading |
| stage (water level) | discharge relationship |
| **Laboratory parameters** | |
| alkalinity | buffering capacity |
| chloride | oil field brines |
| sulfate | oil field brines, anion balance |
| color | aesthetics, photosynthetic activity |
| total dissolved solids | oil field brines, sewage treatment plant effluent |
| total suspended solids | erosion |
| oil and grease | oil spills |
| fecal coliform | septic leakage, public health |
| fecal streptococcus | livestock/wildlife contamination |

Table 3. Field and laboratory procedures used to analyze the selected water quality parameters.

| Parameter | Method of Analysis |
| --- | --- |
| | <u>Field Parameters</u> |
| temperature & specific conductance | Yellow Springs Instruments Model 33 S-C-T meter |
| turbidity | Turner Designs Model 40-100 Nephelometer |
| pH | Orion Research Model 221 pH meter with Ross combination electrode |
| dissolved oxygen | Orion Research Model 9708 dissolved oxygen probe |
| stage (water level) | visual estimate/staff gauge |
| | <u>Laboratory Parameters</u> |
| alkalinity | Potentiometric titration to preselected endpoint; method 403 (APHA, 1985) |
| chloride | Argentometric method with silver nitrate; method 407 (APHA, 1985) |
| sulfate | Turbidimetric method, precipitation with barium chloride; method 426.C (APHA, 1985) |
| color | Platinum cobalt comparison method; method 204.A (APHA, 1985) |
| total dissolved solids | Total filterable residue dried at 103-105°C; method 209.C (APHA, 1980) |
| total suspended solids | Total suspended solids dried at 103-105°C; method 209.C (APHA, 1985) |
| oil and grease | Partition gravimetric method, extraction with trichlorotrifluoroethane; method 503.A (APHA, 1985) |
| fecal coliform | Fecal coliform membrane filter procedure; method 909.C (APHA, 1985) |
| fecal streptococcus | Membrane filter technique; method 910.B (APHA, 1985) |

Table 4. Texas State Water Quality Standards for stream segments within Big Thicket National Preserve (Texas Water Commission, 1986).

<u>Neches River (segment 0602)</u>: from a point 11.3 kilometers (7.0 miles) upstream of Interstate Highway 10 to Town Bluff Dam

| | | | |
|---|---|---|---|
| chloride | 50 mg/L | pH range | 6.0 - 8.5 |
| sulfate | 30 mg/L | fecal coliform | 200 colonies/100 mL |
| total dissolved solids | 150 mg/L | dissolved oxygen | no less than 5.0 mg/L |
| oil and grease | 0 mg/L | temperature | 91°F (33°C) |

<u>Pine Island Bayou (segment 0607)</u>: from the confluence with the Neches River to FM 787

| | | | |
|---|---|---|---|
| chloride | 150 mg/L | pH range | 6.0 - 8.5 |
| sulfate | 50 mg/L | fecal coliform | 200 colonies/100 mL |
| total dissolved solids | 300 mg/L | dissolved oxygen | no less than 5.0 mg/L |
| oil and grease | 0 mg/L | temperature | 95°F (35°C) |

<u>Village Creek (segment 0608)</u>: from the confluence with the Neches River to Lake Kimble Dam

| | | | |
|---|---|---|---|
| chloride | 150 mg/L | pH range | 6.0 - 8.5 |
| sulfate | 75 mg/L | fecal coliform | 200 colonies/100 mL |
| total dissolved solids | 300 mg/L | dissolved oxygen | no less than 5.0 mg/L |
| oil and grease | 0 mg/L | temperature | 90°F (32°C) |

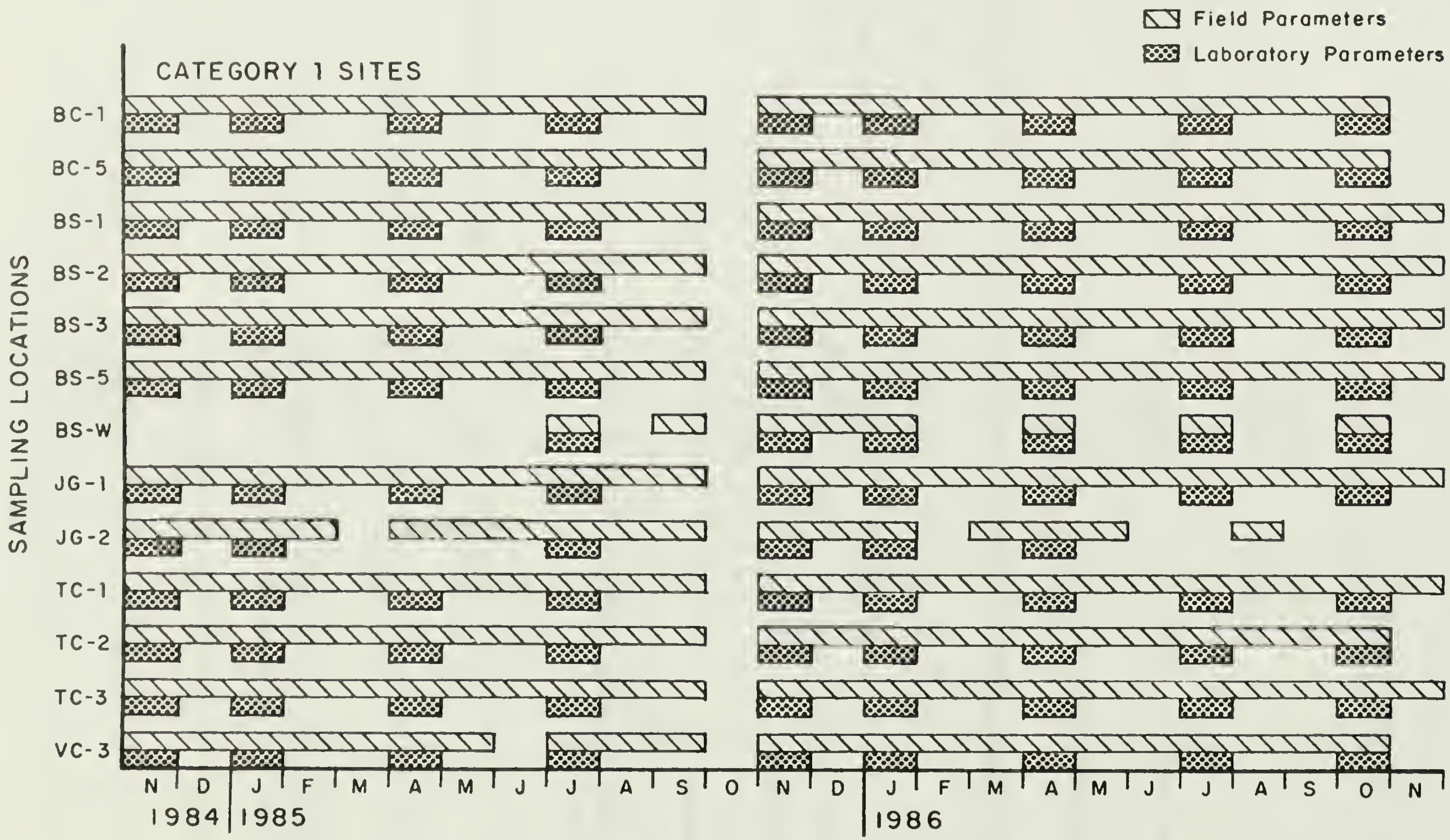



Figure 3. Sampling schedule (1984-1986) for Category 1 water quality monitoring sites in Big Thicket National Preserve, Texas.

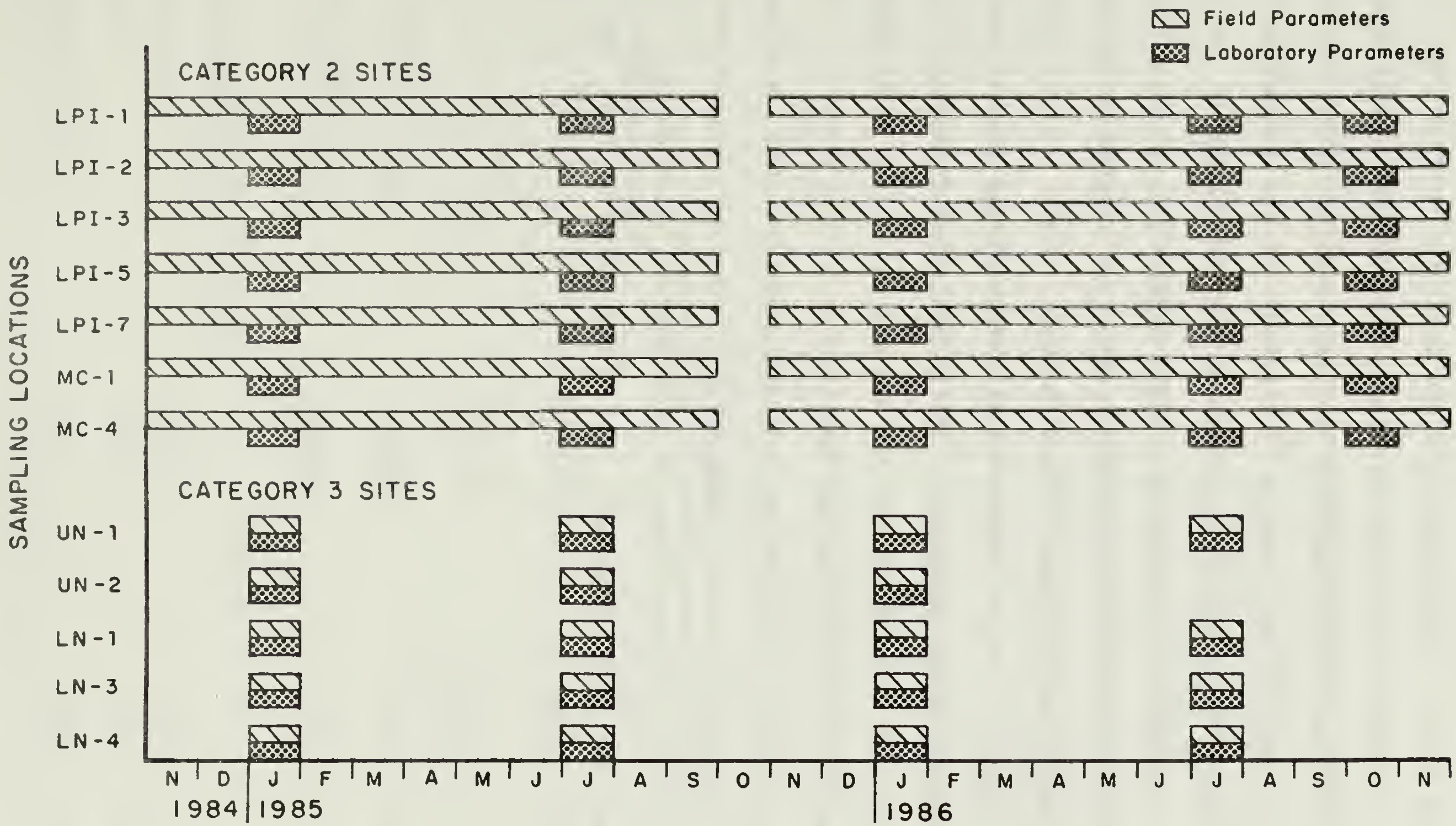



Figure 4. Sampling schedule (1984-1986) for Category 2 and 3 water quality monitoring sites in Big Thicket National Preserve, Texas.

maintaining their good water quality conditions; consequently, they are sampled more often. Field parameters are monitored monthly in Category 1 streams; parameters requiring laboratory analysis are sampled four times a year, which is the minimum sampling frequency designated by the Texas Water Commission (1986). On Category 2 streams, field parameters are again sampled monthly, but laboratory parameters are monitored on a semiannual schedule. Category 2 streams have shown degraded water quality conditions in past studies, and the present NPS monitoring program will detect any changes in water quality from external sources.

The Category 3 stream (Neches River) is monitored twice a year for both field and laboratory parameters. The Neches River is already monitored by other federal and state agencies, and the NPS has access to their data bases for further water quality information.

One site does not follow the sampling schedule just described. Site BS-W on Big Sandy Creek is sampled on a "need-only basis;" that is, when downstream conditions show signs of deteriorating water quality, BS-W will be sampled to help determine the source of the poor water quality conditions.

## RESULTS

### Precipitation and Discharge

As part of its surface water monitoring network, the U.S. Geological Survey (USGS) maintains four stations in the Big Thicket region (Table 5 and Fig. 5). These four stations provide discharge and water quality data on the one river and three largest streams in the area. In addition, three stations operated by the National Oceanographic and Atmospheric Administration (NOAA) national climatological network were selected to provide information on precipitation patterns in the area (Table 5 and Fig. 5). Data from both networks are used to relate precipitation to stream discharge.

Table 5. Surface water and precipitation stations near Big Thicket National Preserve.

| Station | Station Number | Period of record |
|---|---|---|
| USGS Gauging Station | | |
| Menard Creek near Rye, Texas | 08066300 | 1966 - present |
| Pine Island Bayou near Sour Lake, Texas | 08041700 | 1968 - present |
| Village Creek near Kountz, Texas | 08041500 | 1925 - present |
| Neches River at Evadale, Texas | 08041000 | 1905 - present |
| NOAA Climatological Station | | |
| Livingston 2 NNE | 5271 | 1936 - present |
| Warren | 9480 | 1952 - present |
| Beaumont City | 0611 | 1887 - present |

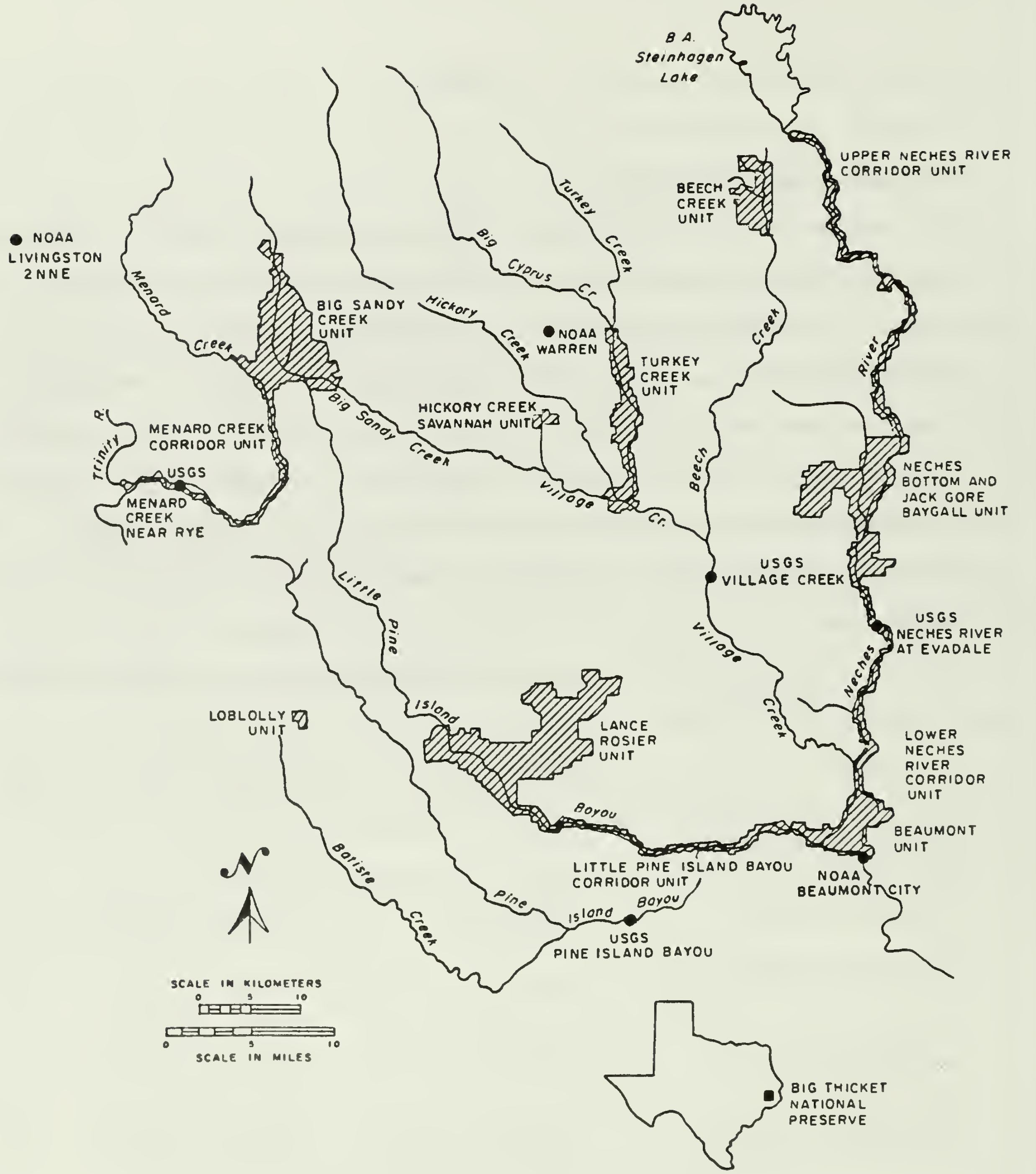



Figure 5. Location of National Oceanographic and Atmospheric Administration climatological and U.S. Geologic Survey gauging stations in and near Big Thicket National Preserve, Texas.

The NOAA climatological stations were selected for their spatial distribution throughout the Big Thicket area. The Livingston station is located in the proximity of the Menard Creek Corridor Unit and the Big Sandy Creek Unit; the station at Warren is centrally positioned within the Big Thicket region, only a few kilometers northwest of the Turkey Creek Unit; and the Beaumont City station is in the southwestern portion of the region, near the Beaumont Unit and Little Pine Island Bayou Corridor Unit.

Mean annual precipitation in the area varies spatially. It is generally higher near the Gulf of Mexico than further inland, due to summer rainstorms moving inland from the gulf and gradually dissipating as they progress northward (Table 6). Consequently, the management units located in the southern portion of Big Thicket National Preserve generally receive more annual rainfall than do units further north.

Table 6. Annual precipitation for selected National Oceanographic and Atmospheric Administration climatic stations.

| Station | Mean annual precipitation (inches) (for period of record) |
|---|---|
| Livingston 2 NNE | 47.96 |
| Warren | 52.03 |
| Beaumont City | 54.50 |

During the initial two years of this monitoring program (November 1984-November 1986), precipitation fluctuated greatly from month to month (Fig. 6). Periods of below-normal precipitation existed from April 1985 through August 1985 and from January 1986 through April 1986. Periods of above-normal precipitation were found in February-March 1985, October-November 1985, May-June 1986, and November 1986. The greatest monthly

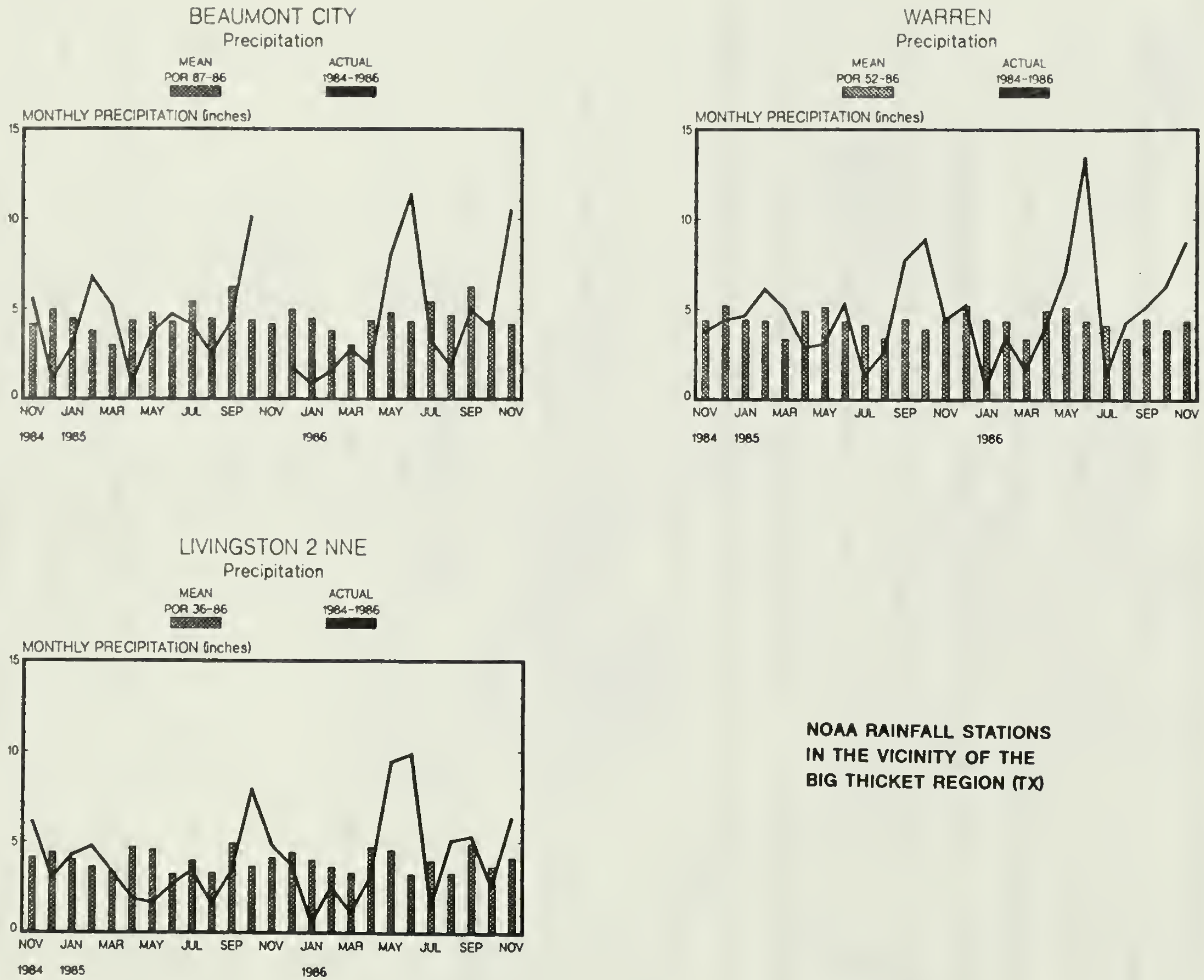



Figure 6. Monthly rainfall (November 1984 - November 1986) and period of record (POR) mean monthly rainfall at three National Oceanographic and Atmospheric Administration rainfall stations in the

rainfall during the period occurred at the Warren station where 13.45 inches (342 mm) fell in June 1986, 9.10 inches (231 mm) above the monthly mean for this station. The lowest monthly rainfall for the study period was recorded at the Livingston station, where 0.62 inches (16 mm) of rain was recorded in January 1986, 3.40 inches (86 mm) below the monthly mean for that station.

Figure 7 presents monthly discharge information (November 1984-November 1986) for four USGS gauging stations in the vicinity of Big Thicket National Preserve. While monthly discharge fluctuates greatly, overall discharge for the Neches River, Village Creek, and Pine Island Bayou was well below their respective period of record means. Discharge in Menard Creek was above this mean (Table 7).

At Menard Creek, Village Creek, and Pine Island Bayou, high discharge periods existed during February-May 1985; October-December 1985; and June-July 1986. Monthly discharges lower than mean period of record flows were found in the spring and summer, April-September 1985 and March-April 1986. The Neches River hydrograph has a similar shape to hydrographs from the other streams, but the discharges do not exhibit as much deviation from the period of record means as do discharges in the other streams.

The smaller fluctuations in the Neches River flow can be explained by the regulating effects of the Town Bluff Dam, located just upstream of Big Thicket National Preserve. Also, the Neches River has a much larger basin area and more flow than the other streams in the preserve, so local precipitation events have a smaller influence on Neches River discharge than on that of the other streams. Table 8 summarizes the extreme monthly discharge values and flow volumes during the period of study.

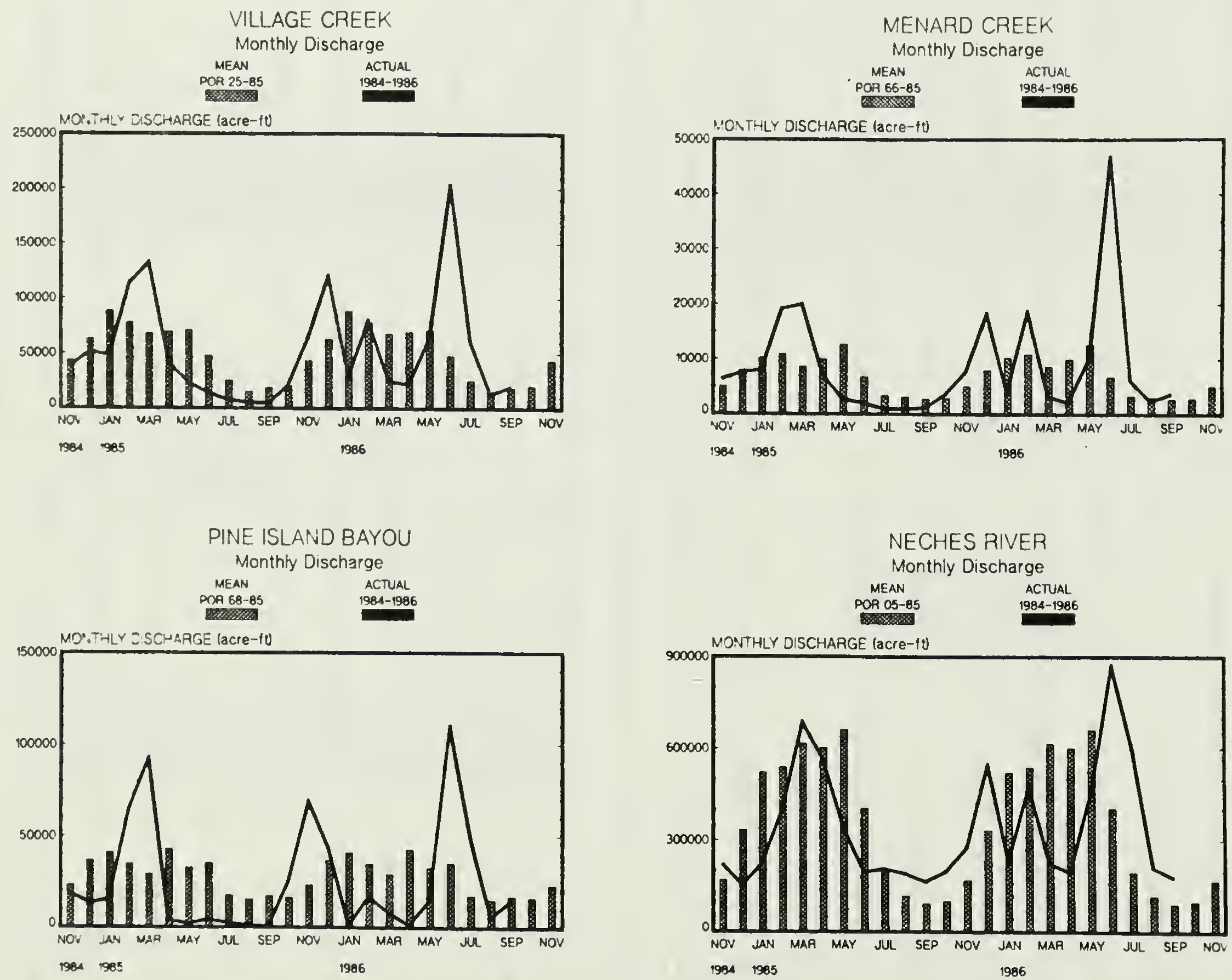



Figure 7. Monthly discharge (November 1984-November 1986) and period of record (POR) mean monthly discharge at four U.S. Geological Survey stations in the vicinity of Big Thicket National Preserve, Texas.

Table 7. Percent differences from the period of record mean annual discharge for water years (WY) 1985 and 1986. (Data obtained directly from the USGS stations indicated.)

| USGS station | Percent difference from mean annual discharge WY 1985 | WY 1986 |
|---|---|---|
| Neches River 08041000 | -16.3% | -3.5% |
| Village Creek 08041500 | -12.3% | -20.9% |
| Pine Island Bayou 08041700 | -16.9% | -7.3% |
| Menard Creek 08066300 | +2.1% | +53.7% |

Table 8. Flow volumes (in acre-feet) for the USGS stations in the vicinity of Big Thicket National Preserve during water years (WY) 1985 and 1986.

| Station and USGS identification number | Annual discharge WY 85 | Annual discharge WY 86 | Max. monthly discharge WY 85-86 | Min. monthly discharge WY 85-86 |
|---|---|---|---|---|
| Neches River 08041000 | 3,634,000 | 4,494,000 | 874,200 Jun 86 | 153,900 Dec 84 |
| Village Creek 08041500 | 532,800 | 734,500 | 203,600 Jun 86 | 5,650 Sep 85 |
| Pine Island Bayou 08041700 | 282,400 | 364,400 | 110,200 Jun 86 | 940 Sep 85 |
| Menard Creek 08066300 | 85,990 | 129,100 | 46,900 Jun 86 | 1,080 Aug 85 |

Relationship between rainfall and discharge. An attempt was made to correlate monthly precipitation with monthly stream discharge using data obtained from the NOAA and the USGS. Precipitation stations were paired

with the closest USGS discharge stations (Table 9) and linear regression analysis was performed, analyzing monthly precipitation amounts versus monthly stream discharge. The resulting correlations were poor ($r^2 < 0.5$, for all tests), indicating that variables other than monthly precipitation at single recording sites influenced discharge in this basin. These variables might include:

- Variability of storm intensity: For a given total volume of rainfall, the precipitation intensities can be very different. For example, a storm with a total volume of three inches could have a duration of 45 minutes to several hours. Higher intensity storms will produce more surface runoff, especially if soil infiltration rates are exceeded, and they generally occur during the summer thunderstorm season. Lower intensity storms are more likely to occur in the colder months.

- Antecedent moisture content: More runoff will occur from a storm event if the soil moisture conditions are wet (high antecedent moisture content) than if the soil is dry.

- Seasonal differences in evaporation and transpiration: Seasonality can be significant in affecting how much water will be retained by the vegetative growth and how much is available for stream flow.

- Inadequate number of recording sites: Precipitation on the watershed occurring at a single monitoring station is not necessarily representative of precipitation over the entire watershed basin being gauged, nor is the precipitation consistent from storm to storm. This variability is especially true for summer thunderstorm activity, which can be localized in distribution.

Table 9. Paired National Oceanographic and Atmospheric Administration (NOAA) and U.S. Geological Survey (USGS) stations used in linear regression analysis.

| USGS gauging station | NOAA climatological station |
|---|---|
| Neches River at Evadale | Beaumont City |
| Pine Island Bayou | Beaumont City |
| Village Creek | Warren |
| Menard Creek | Livingston 2 NNE |

Category 1 Streams

Category 1 streams include those exhibiting the best water quality within the preserve. These include Beech Creek in the Beech Creek Unit; Big Sandy Creek in the Big Sandy Creek Unit; Turkey Creek and a small portion of Village Creek in the Turkey Creek Unit; and Black Creek, located in the Neches Bottom and Jack Gore Baygall Unit (Fig. 8). Pollutant levels are expected to be low in these streams since human activities and land uses in and around the management units are relatively few in comparison with other management units. Because of the good water quality, Category 1 streams are managed with the highest protection priorities, including frequent monitoring and stringent evaluation of mineral operating permits. The eventual quantification and establishment of antidegradation water quality standards would be useful.

Stream Descriptions

Beech Creek. This stream originates outside of the Beech Creek management unit in eastern Tyler County and flows 52.3 km (32.5 mi) to its confluence with Village Creek. Within the management unit, Beech Creek is 10.3 km (6.4 mi) long and receives inflow from several smaller tributaries. Monitoring site BC-1 is located on one of these tributaries, Little Beach Creek, in the northern part of the management unit. The major land-use activity in the area is timber harvesting, for which clearcutting is the most frequent technique utilized in the watershed.

Big Sandy Creek. Beginning in northern Polk County, Big Sandy Creek flows southeasterly 6.4 km (4.0 mi) before entering the Big Sandy Creek management unit. From there, it meanders for approximately 34.6 km (21.5 mi) within the preserve, continuing past the Hardin-Polk County line where it is renamed Village Creek (Harrel and Newberry, 1981). Here again, timber

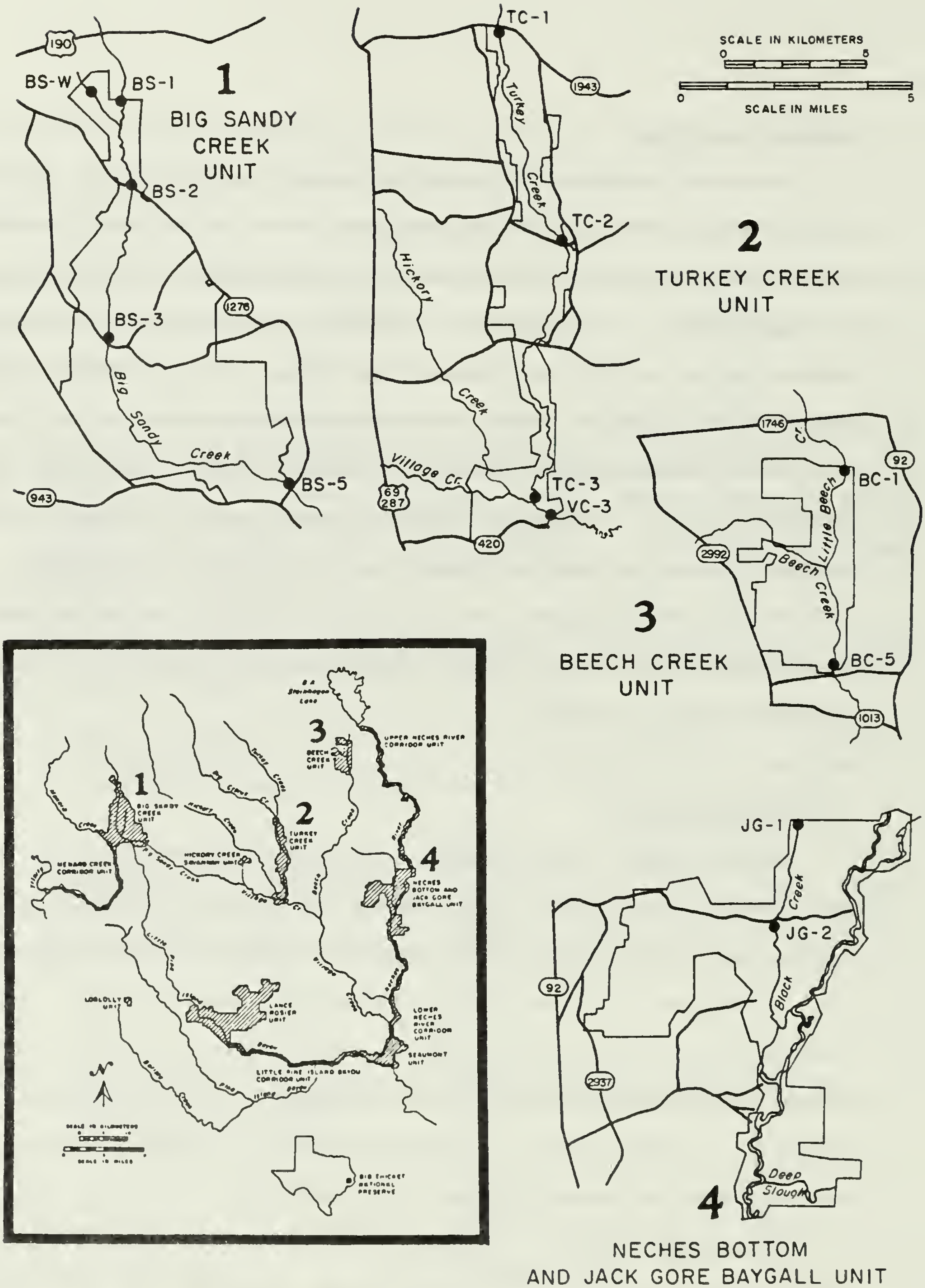



Figure 8. Locations of monitoring sites on Category 1 streams in Big Thicket National Preserve, Texas.

harvesting near the Big Sandy Creek management unit is the greatest concern to water quality, although proposed oil and gas activity in the Alabama-Coushatta Indian Reservation, north of the unit boundary, may pose problems in the future.

Turkey Creek. The Turkey Creek management unit is centrally located within the preserve and contains Turkey Creek and small reaches of Hickory Creek and Village Creek. Turkey Creek flows southward for more than 30 km (18 mi) through the management unit before joining Village Creek. Human activities and land uses affecting water quality in Turkey Creek and Village Creek include five permitted waste discharges originating from the community of Woodville, upstream of the management unit (Harrel and Commander, 1980). Oil and gas activities are also of concern, with operations located both within and adjacent to the unit.

Black Creek. Flowing through the Neches Bottom and Jack Gore Baygall Unit is Black Creek. Black Creek originates in southeastern Tyler County and follows a series of sloughs before entering the Neches River near the center of the management unit. Many swamps and sloughs characterize the slow-moving channel of Black Creek, and the banks of the stream support a diverse vegetation community. During high-flow and flood conditions, the main stream channel can become indistinct and confused with the many tributaries and waterways in the unit. At these times, access to monitoring sites on Black Creek may be difficult, as demonstrated by the number of times site JG-2 was omitted from sampling because of high-water conditions. Human activities influencing water quality in Black Creek include oil and gas production sites located in close proximity to Black Creek within and northwest of the unit, adjacent timber harvesting, and recreational uses such as hunting camps situated along the creek north of the unit.

Water Quality Summary

Seasonal temperature variations for all Category 1 streams during the study period (Fig. 9) are consistent from stream to stream and with data collected during prior studies (Flora et al., 1985; Hughes et al., 1986). The highest summer stream temperatures peak around 30°C (86°F) in all streams, while the low temperatures drop below 10°C (50°F) in December and January. There is little temperature variation longitudinally along any specific stream, probably due to the homogeneity of topography, vegetative canopy, and geomorphic features along the stream channels.

Dissolved oxygen (DO) concentrations are generally above 5.0 mg/L for all Category 1 streams except Black Creek and Beech Creek (Fig. 10). On several occasions, the DO concentrations in both Black Creek and Beech Creek fell below the Texas state water quality standard of 4.0 mg/L for intermediate-quality aquatic habitat, and a few samples were reported below 3.0 mg/L, the Texas state standard for poor-quality aquatic habitat. These low DO readings are thought to be naturally occurring in some unimpacted waters of southeastern Texas. A combination of high summer temperatures, stagnant, low flows, and heavy natural organic loading contribute to conditions that may naturally cause these low DO concentrations. At times, only isolated pools of water existed at these sites, with no inflow or outflow to replenish the oxygen. Such was the case at site BC-1 during June 1985 when a DO reading of 0.9 mg/L was recorded. The other low readings occurred under similar conditions. While these conditions are temporarily damaging to resident aquatic communities, higher DO concentrations reestablish when higher flow conditions return.

The pH levels for Category 1 streams also fall within the range expected for streams in southeast Texas (Fig. 11). Median pH value ranged

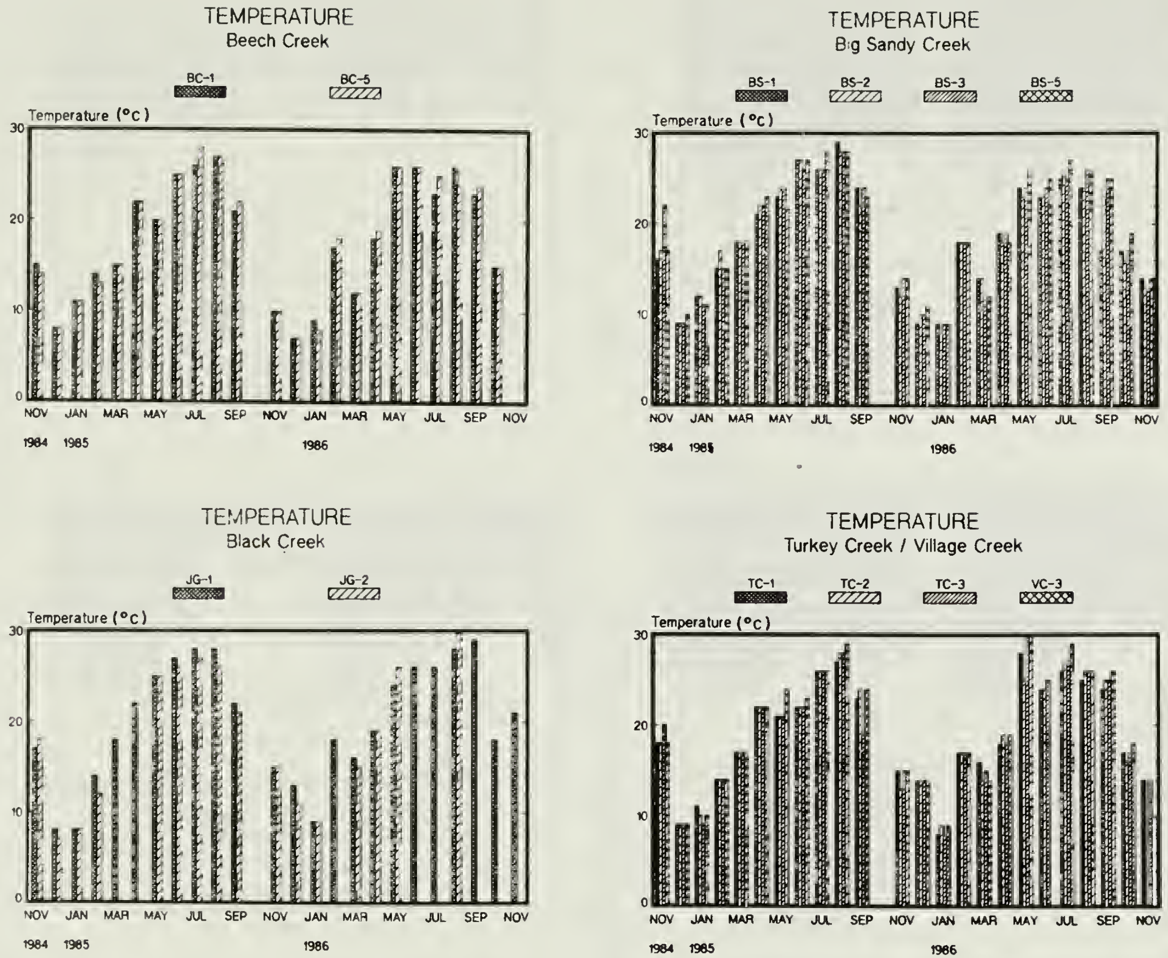



Figure 9. Monthly stream water temperatures for Category 1 stream monitoring sites (November 1984 - November 1986).

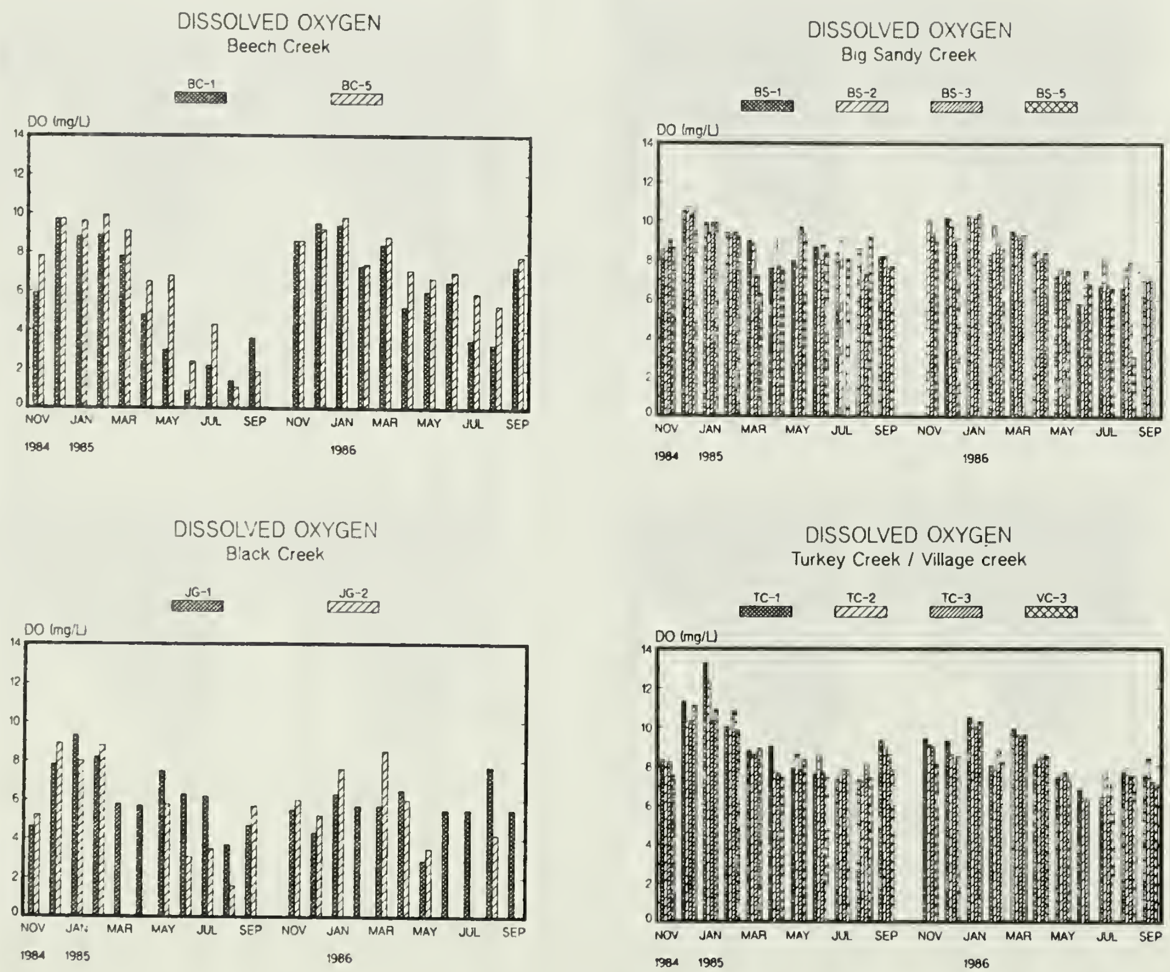



Figure 10. Monthly dissolved oxygen concentrations for Category 1 stream monitoring sites (November 1984 - November 1986).

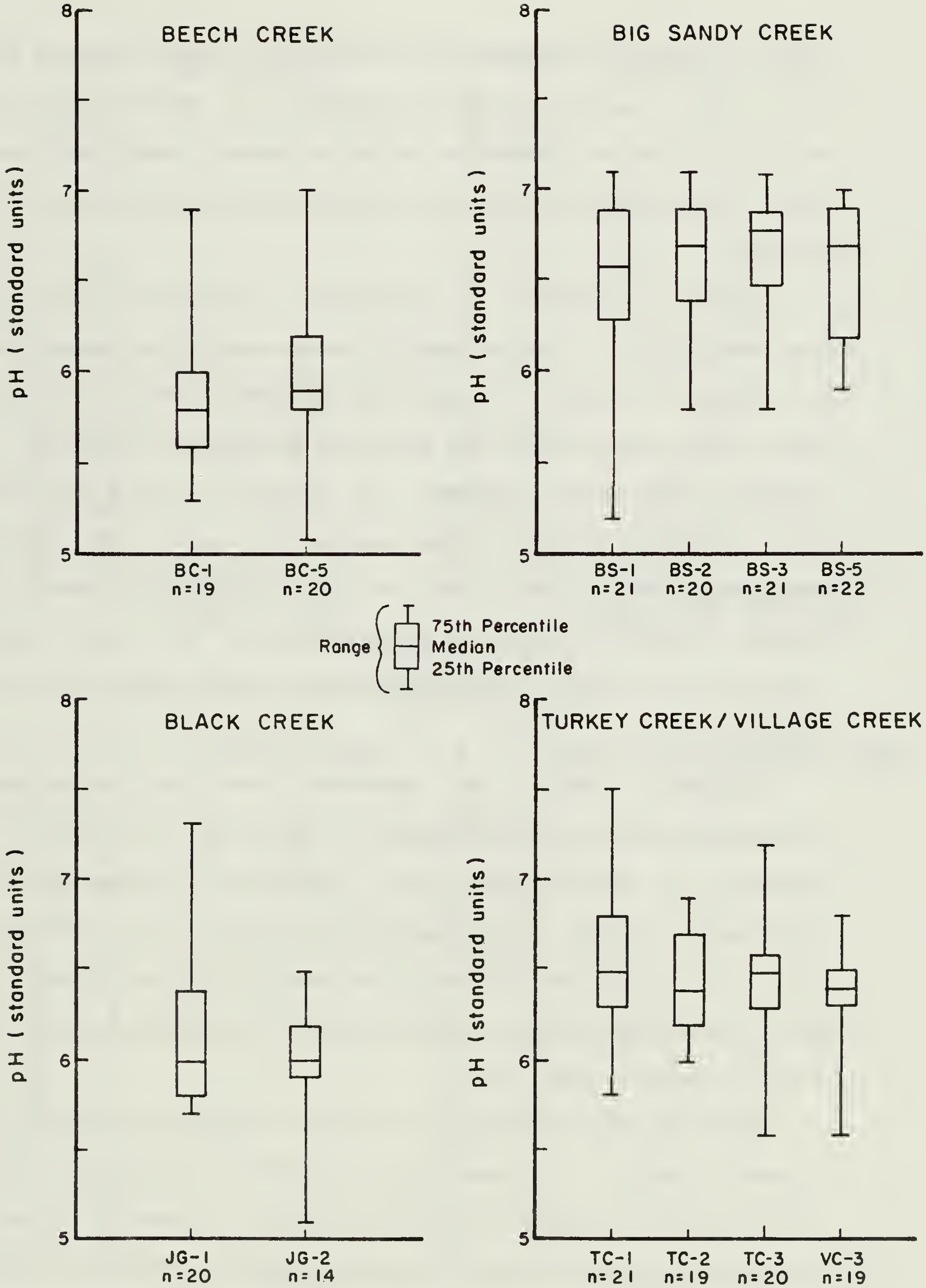



Figure 11. pH medians and ranges for Category 1 stream monitoring sites (November 1984-November 1986).

from 5.9 at Beech Creek and Black Creek to 6.8 pH units at Big Sandy Creek. The slightly acidic conditions recorded at Beech Creek and Black Creek monitoring sites are thought to be due to natural conditions: brush and tree debris in the streams decompose and create weak organic acids, which depress pH levels.

Specific conductance in Category 1 streams is generally low at all stations (Fig. 12). Median specific conductance values range from a low of 46 μmhos/cm at BC-5 to a high of 85 μmhos/cm at BS-2. The sites on Black Creek in the Neches Bottom and Jack Gore Baygall unit recorded the highest specific conductance readings: 179 μmhos/cm at JG-1 and 172 μmhos/cm at JG-2. Both were recorded on the same day in August 1986 during low-flow conditions, though the cause for these slightly elevated readings is unknown. Specific conductance measurements for the other sites are all indicative of little human impact: the highest measurements less than 110 μmhos/cm.

Turbidity levels are separated into low-flow measurements and intermediate/high-flow measurements to demonstrate the effects of increased discharge on turbidity (Fig. 13). Differences do appear for most streams, with higher turbidity levels reported for higher flow conditions. Beech Creek is an exception, reporting low turbidity values for both high and low flows. No unusually high turbidity levels were reported at any Category 1 sites during the study period.

Chloride concentrations are low at all monitoring sites on Category 1 streams (Fig.14). No measurement exceeded 20 mg/L (as $Cl^-$), and median concentrations ranged from 8 mg/L to 13 mg/L. Chloride is a good indicator of wastes from oil and gas operations. The brine material associated with oil recovery contains very high chloride concentrations and is, therefore, easily detected if discharged into nearby streams.

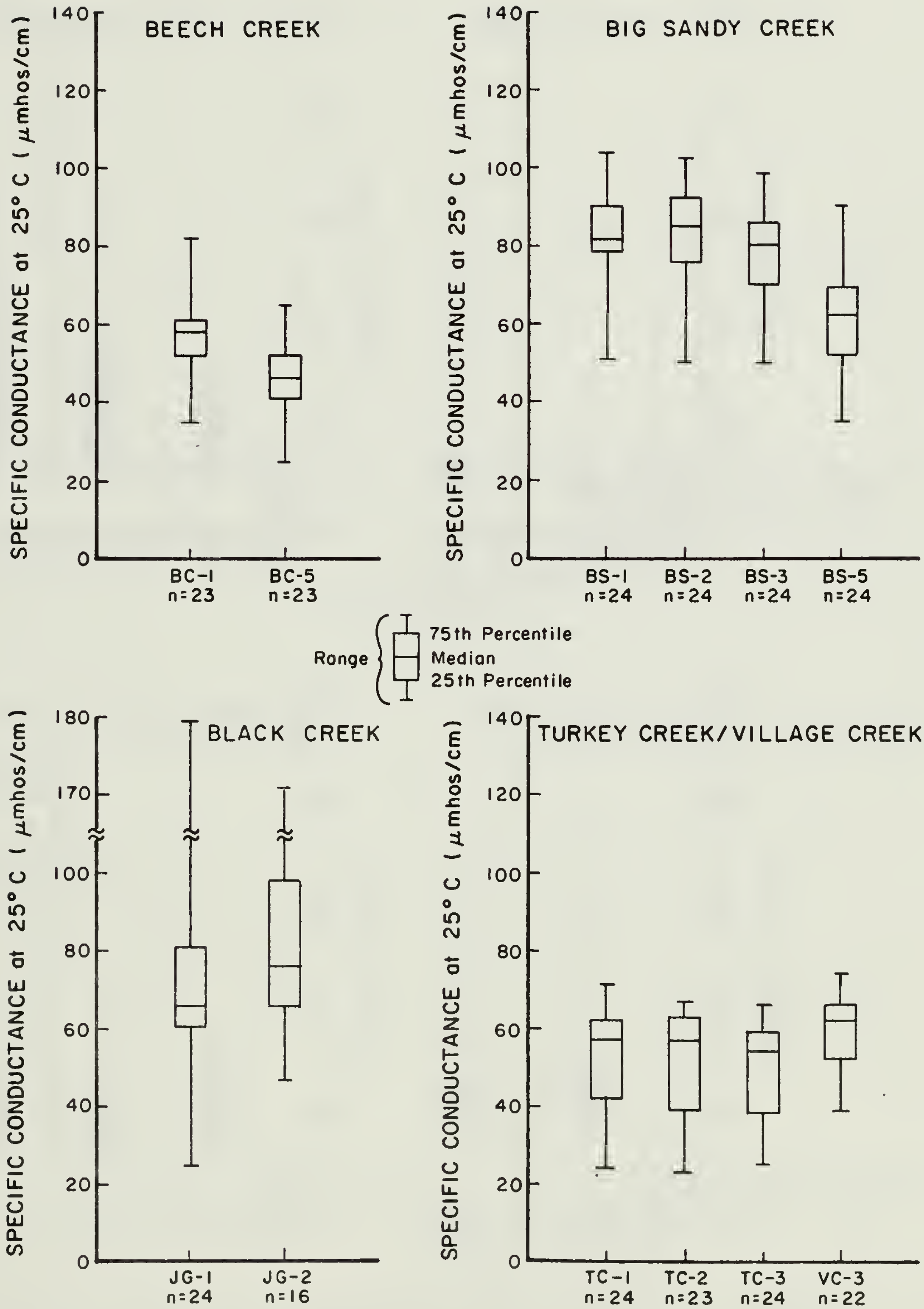



Figure 12. Specific conductance medians and ranges for Category 1 stream monitoring sites (November 1984-November 1986).

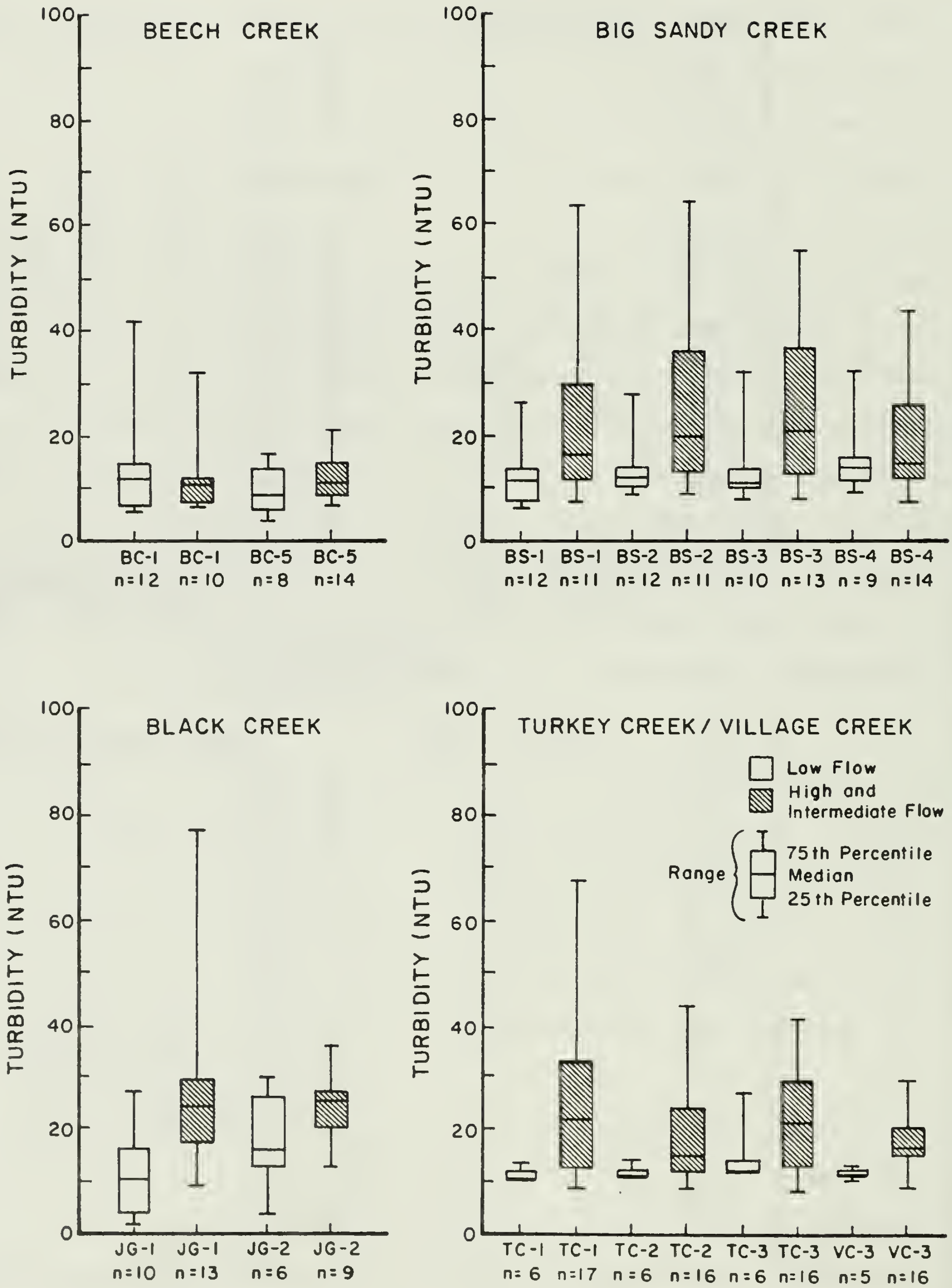



Figure 13. Turbidity medians and ranges during low-flow and intermediate/high-flow conditions for Category 1 streams (November 1984 - November 1986).

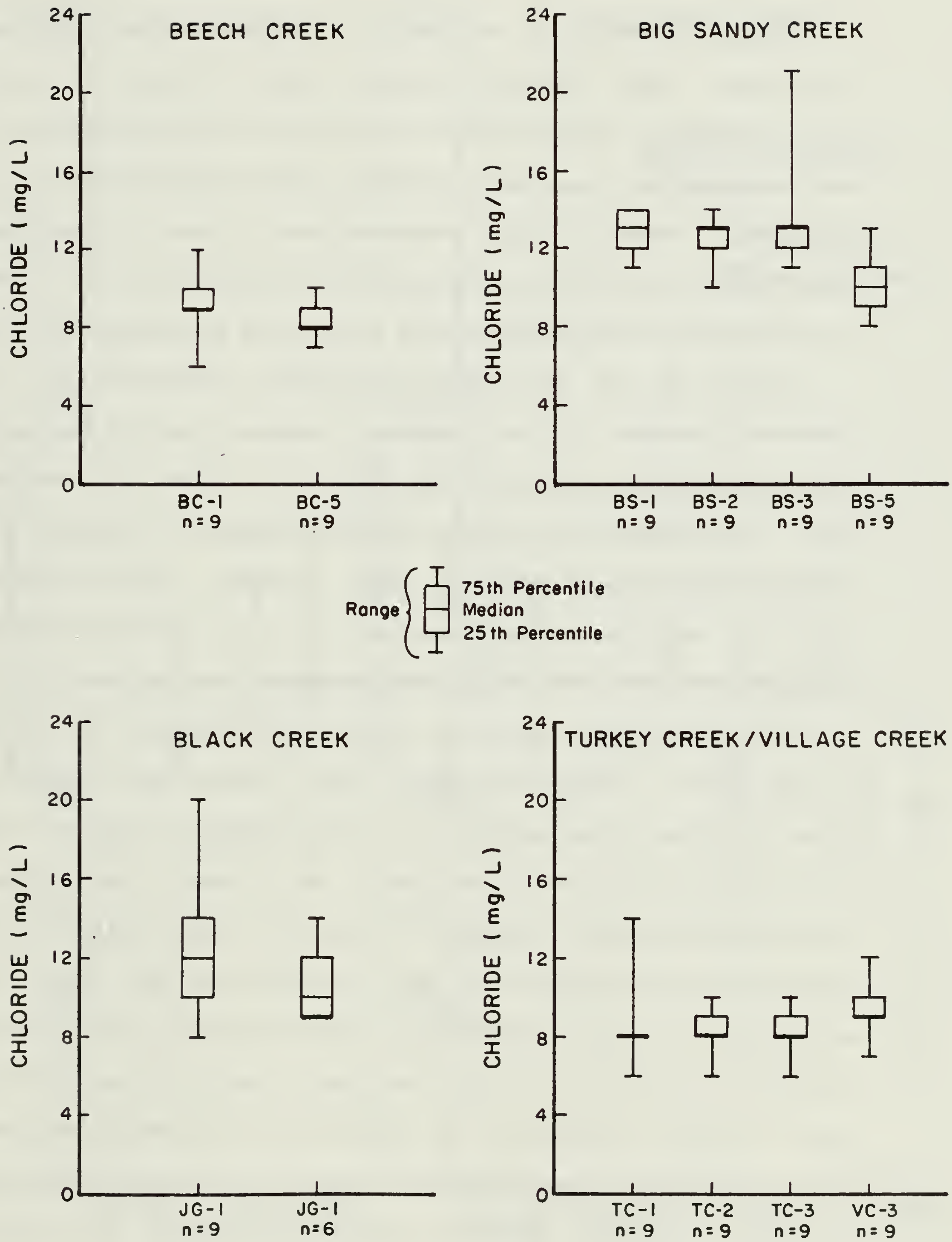



Figure 14. Chloride median concentrations and ranges for Category 1 stream monitoring sites (November 1984-November 1986).

Bacteria levels in the Category 1 streams are not excessive and only occasionally reach slightly elevated levels (Figs. 15 and 16). The geometric mean for fecal coliform concentrations for all Category 1 stations never exceeded the Texas state standard of 200 colonies/100 mL for contact recreation. Sporadic high concentrations of fecal streptococcus bacteria (over 500 colonies/100 mL) were observed in Black Creek and Big Sandy Creek, but overall the fecal streptococcus levels were not unusual for the area.

Tables 10 and 11 provide descriptive statistics for additional parameters sampled in the Category 1 streams. Most of the data presented represents the naturally occurring levels for streams of southeast Texas. High color values on Beech Creek and Black Creek are reported, probably due to decomposing organic matter in these streams. Total suspended solids (TSS) and alkalinity concentrations are low, and total dissolved solids (TDS) concentrations are average for the area, ranging from 50 to 132 mg/L.

Only the highest values for each site are reported for sulfate and for oil and grease. Sulfate was sampled only during the quarterly sampling trips, but due to the turbidity and color content of samples, sulfate could not reliably be reported below 10 mg/L. As a result, few sulfate samples had specific values assigned to them. The higher sulfate concentrations ranged from about 20 mg/L to 24 mg/L in Beech Creek and Black Creek. Oil and grease was only sampled when it was suspected, and often it was below the detection limit of 10 mg/L. Detectable concentrations of oil and grease were recorded infrequently at some Turkey Creek and Black Creek sampling sites. Although the exact source of the oil and grease is undetermined, its occasional presence indicates land-use activities that could present continued problems in the future.

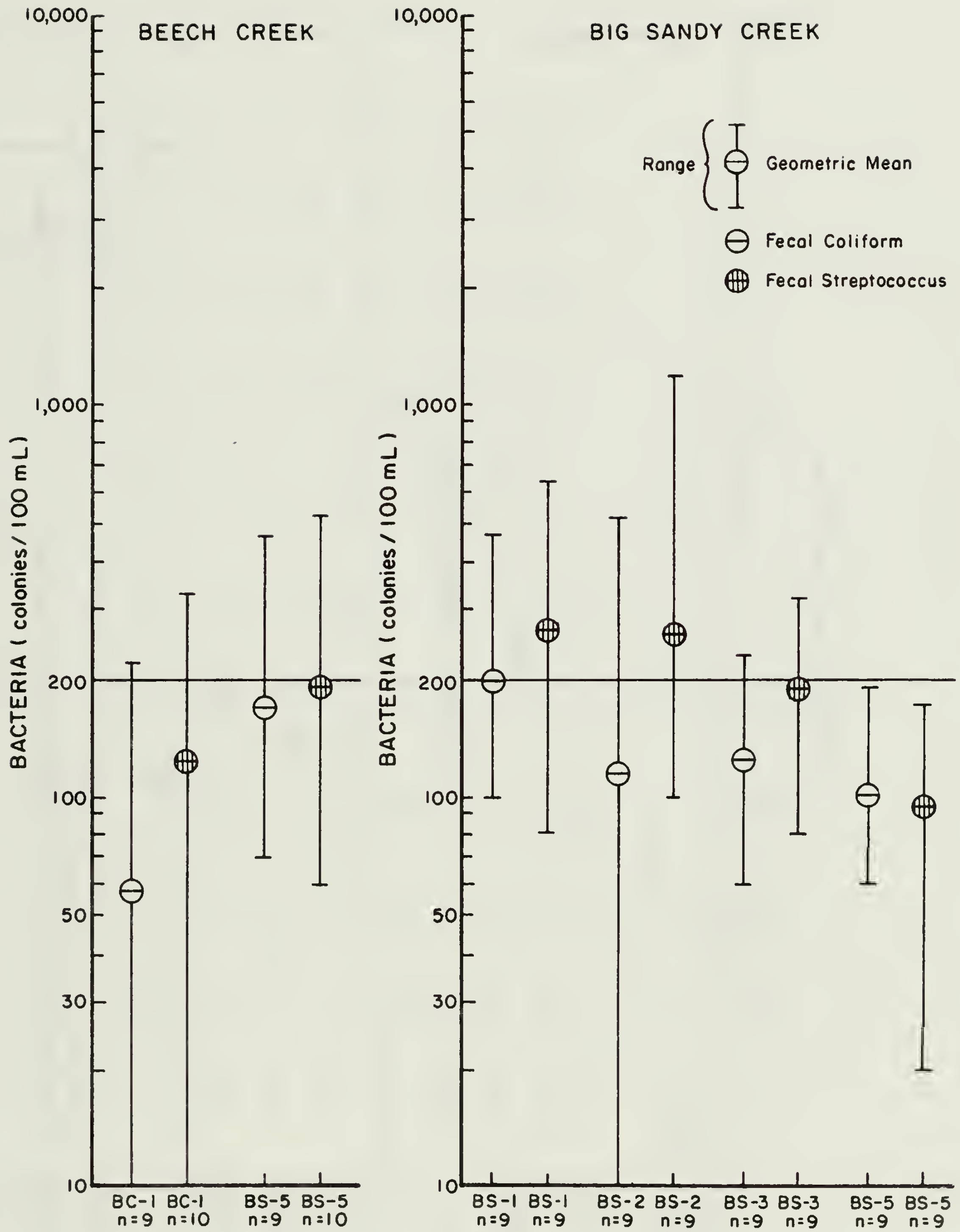



Figure 15. Geometric means and ranges for fecal coliform bacteria and fecal streptococcus bacteria for Beech Creek and Big Sandy Creek (November 1984 - November 1986).

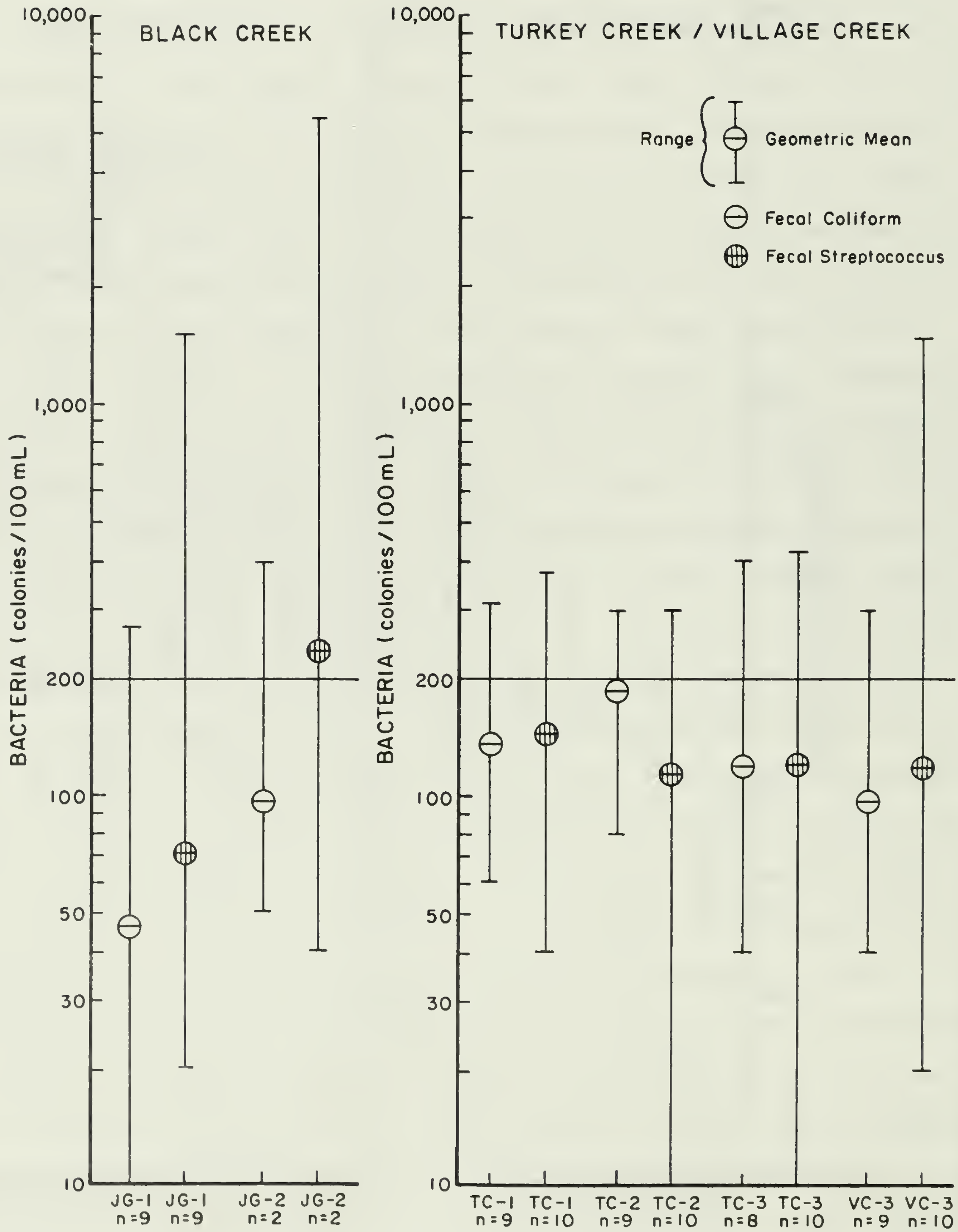



Figure 16. Geometric means and ranges for fecal coliform bacteria and fecal streptococcus bacteria for Black Creek, Turkey Creek, and Village Creek (November 1984 - November 1986).

Table 10. Means and ranges for alkalinity, color, and sulfate in Category 1 streams (November 1984 - November 1986).

| | | BC-1 | BC-5 | BS-1 | BS-2 | BS-3 | BS-5 | JG-1 | JG-2 | TC-1 | TC-2 | TC-3 | VC-3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | high | 12 | 14 | 28 | 30 | 28 | 20 | 19 | 10 | 16 | 16 | 16 | 16 |
| (mg/L as $CaCo_3$) | mean | 8 | 8 | 23 | 25 | 23 | 17 | 9 | 8 | 13 | 14 | 12 | 13 |
| | low | 4 | 5 | 18 | 20 | 16 | 14 | 4 | 5 | 10 | 10 | 10 | 8 |
| | n | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 6 | 9 | 9 | 9 | 9 |
| Color | high | 300 | 175 | 90 | 70 | 80 | 80 | 250 | 250 | 90 | 85 | 120 | 180 |
| (Pt-Co units) | mean | 159 | 120 | 58 | 48 | 48 | 54 | 137 | 176 | 52 | 53 | 61 | 79 |
| | low | 100 | 75 | 30 | 30 | 30 | 30 | 35 | 65 | 35 | 35 | 35 | 45 |
| | n | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 6 | 9 | 9 | 9 | 9 |
| Sulfate (mg/L) (maximum values) | | 24 | 20 | | | | | 19 | 15 | | | | |

Table 11. Means and ranges for TSS, TDS, and oil and grease in Category 1 streams (November 1984 - November 1986).

| | | BC-1 | BC-5 | BS-1 | BS-2 | BS-3 | BS-5 | JG-1 | JG-2 | TC-1 | TC-2 | TC-3 | VC-3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TSS | high | 17 | 13 | 12 | 17 | 16 | 15 | 15 | 18 | 24 | 30 | 37 | 20 |
| (mg/L) | mean | 8 | 6 | 8 | 10 | 10 | 10 | 9 | 12 | 12 | 15 | 20 | 11 |
| | low | 3 | 2 | 5 | 5 | 4 | 5 | 5 | 8 | 8 | 6 | 6 | 6 |
| | n | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 6 | 9 | 9 | 9 | 9 |
| TDS | high | 132 | 102 | 109 | 110 | 110 | 98 | 137 | 139 | 78 | 77 | 84 | 98 |
| (mg/L) | mean | 95 | 80 | 90 | 93 | 89 | 79 | 114 | 119 | 68 | 67 | 68 | 82 |
| | low | 66 | 63 | 78 | 81 | 77 | 65 | 75 | 94 | 52 | 52 | 50 | 67 |
| | n | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 6 | 8 | 9 | 9 | 9 |
| Oil and grease (mg/L) (maximum values) | | | | 31 | | | | 31 | 24 | | 35 | | 40 |

Data Comparisons: U.S. Geological Survey Water Quality Stations

Until 1985, the USGS maintained a monitoring station on Village Creek (USGS 08041500) located downstream from the confluence with Beech Creek. The limited amount of information available from this station can be compared with data collected by the NPS. The closest NPS monitoring site is VC-3, which is situated several miles upstream of the USGS 08041500 site.

Constituents sampled in both monitoring programs include temperature, specific conductance, chloride, sulfate, and total dissolved solids (TDS). Temperature and sulfate were similar at both sites; mean concentrations for sulfate are below 10 mg/L. Mean chloride concentrations differ slightly: USGS data show a mean of 16 mg/L of chloride at station 08041500, while the NPS reports a mean of 9 mg/L at VC-3. The increase in chloride concentration could be a result of land-use impacts occurring between the VC-3 and USGS station 08041500 or influence from Beech Creek.

Slight differences also exist in TDS concentrations and specific conductance values, with the USGS reporting a slightly higher mean specific conductance and the NPS reporting a slightly higher TDS mean concentration. This is unusual, because TDS and specific conductance normally have a linear relationship. However, TDS and specific conductance determinations for both monitoring sites fall within ranges that are representative of streams in the region; variations could be due to minor differences in sampling date or analytical technique.

Category 2 Streams

Category 2 streams include those streams that have previously shown impacts of pollution from land-use activities. Category 2 streams include Menard Creek, which flows through the Menard Creek Corridor Unit, and the Little Pine Island Bayou-Pine Island Bayou system (Fig. 17), which flows

through the Lance Rosier, Little Pine Island Bayou Corridor, and Beaumont units of Big Thicket National Preserve. Both of these systems have displayed poor water quality characteristics in past sampling programs (Harrel and Bass, 1979; Harrel and Darville, 1978). Generally, Category 2 streams receive more permitted point source discharges of sewage effluent than do Category 1 streams, and they are also more seriously affected by contaminants associated with oil and gas production and other nonpoint source activities. Field parameters were sampled monthly in the Category 2 streams, and the laboratory parameters were monitored semiannually. In addition, USGS monitoring stations located on Menard Creek (08066300) and Pine Island Bayou (08041700) provided additional water quality information during the 1984-1986 study period (Appendix B).

Stream Descriptions

Menard Creek. This stream originates in central Polk County and flows approximately 77 km (48 mi) before its confluence with the Trinity River. Menard Creek is the preserve's only stream within the Trinity River basin; all other streams drain into the Neches River. The lower 30 km (19 mi) of Menard Creek is bounded by the Menard Creek Corridor Unit of Big Thicket National Preserve. This unit is narrow, at times only a few meters wide. As a result, in some places only a small buffer strip separates Menard Creek from surrounding land-use activities. Land uses bordering Menard Creek include timber harvesting, agriculture, oil and gas operations, and residential development.

Little Pine Island Bayou-Pine Island Bayou. The other Category 2 stream in the preserve is the Little Pine Island Bayou-Pine Island Bayou system. Little Pine Island Bayou originates in Hardin County and flows southeast for 74 km (64 mi) before its confluence with Pine Island Bayou.

Little Pine Island Bayou flows through the Lance Rosier Unit and the Little Pine Island Bayou Corridor Unit, then into Pine Island Bayou above Bevil Oaks. From there it continues through the Beaumont Unit of the preserve before emptying into the Neches River. Monitoring sites LPI-5 and LPI-7 (Fig. 17) are located on Pine Island Bayou below the confluence with Little Pine Island Bayou. External activities influencing water quality in Little Pine Island Bayou include timber harvesting, oil and gas production and storage areas, agriculture, and residential developments that include small sewage treatment plants and septic tank systems.

These same impacts exist throughout the entire Pine Island Bayou watershed, located primarily outside the preserve's boundary. Pine Island Bayou may transport pollutants from other sources within its watershed into the preserve, affecting water quality in both the lower section of the Little Pine Island Bayou Corridor Unit and in the Beaumont Unit.

## Water Quality Summary

Seasonal variations in stream temperature for Category 2 streams are similar to those observed in the Category 1 streams discussed previously (Fig. 18). Stream temperatures peak at around 30°C (86°F) during the low-flow periods of the summer, and seasonal low temperatures occur in December and January, falling as low as 6°C (43°F) during this study. No significant temperature differences between sites were noted for locations on either Menard Creek or Little Pine Island Bayou and Pine Island Bayou.

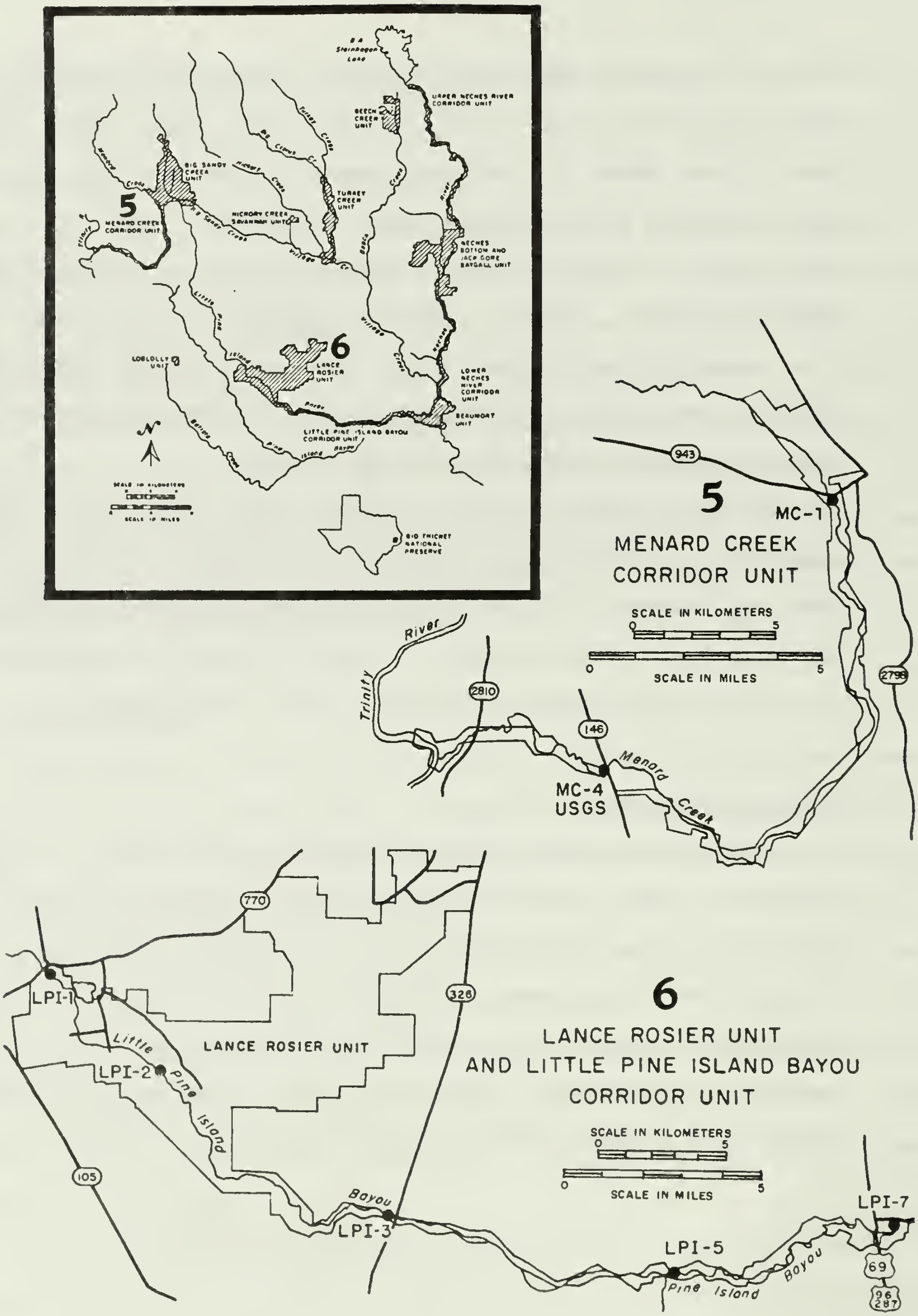
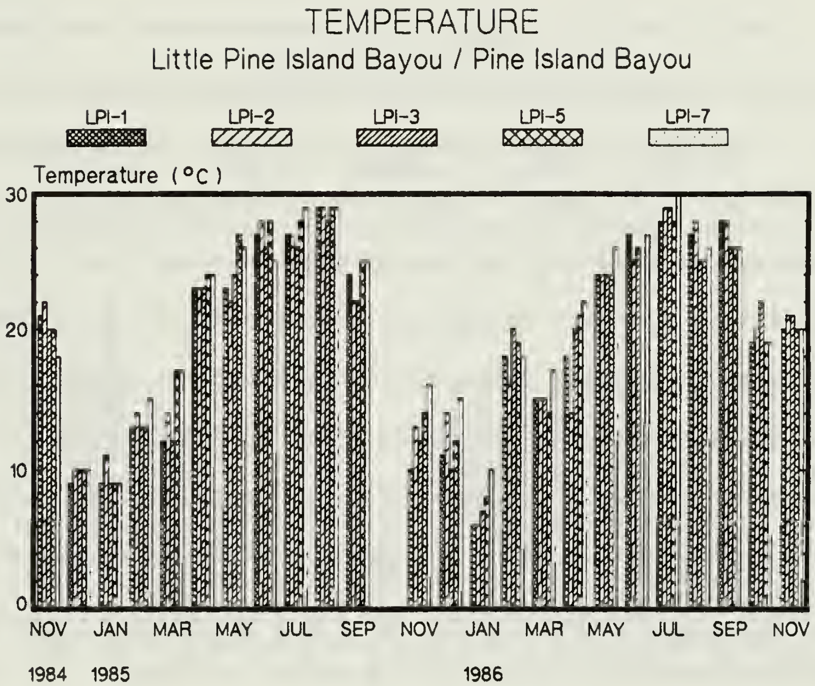



Figure 17. Locations of monitoring sites for Category 2 streams in Big Thicket National Preserve, Texas.



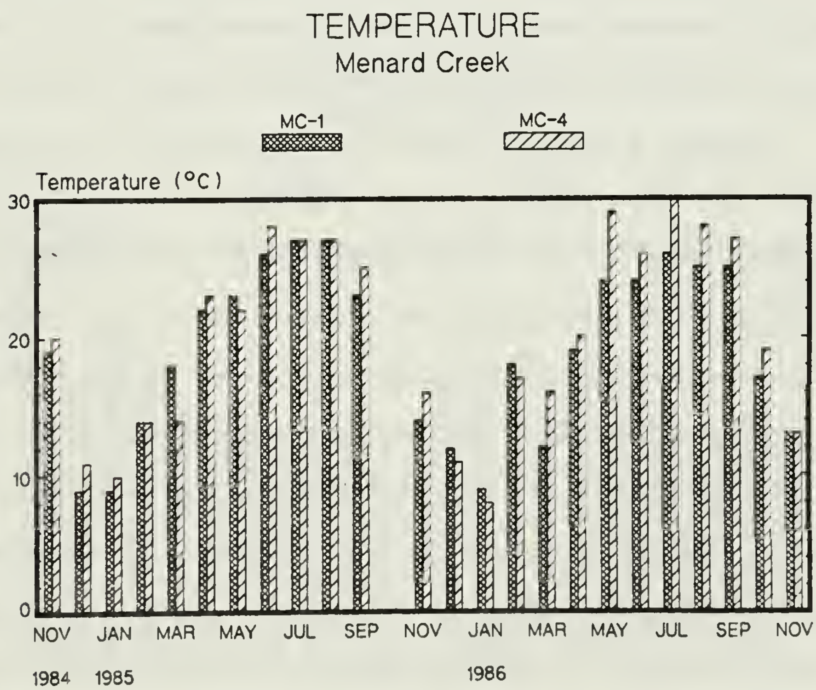



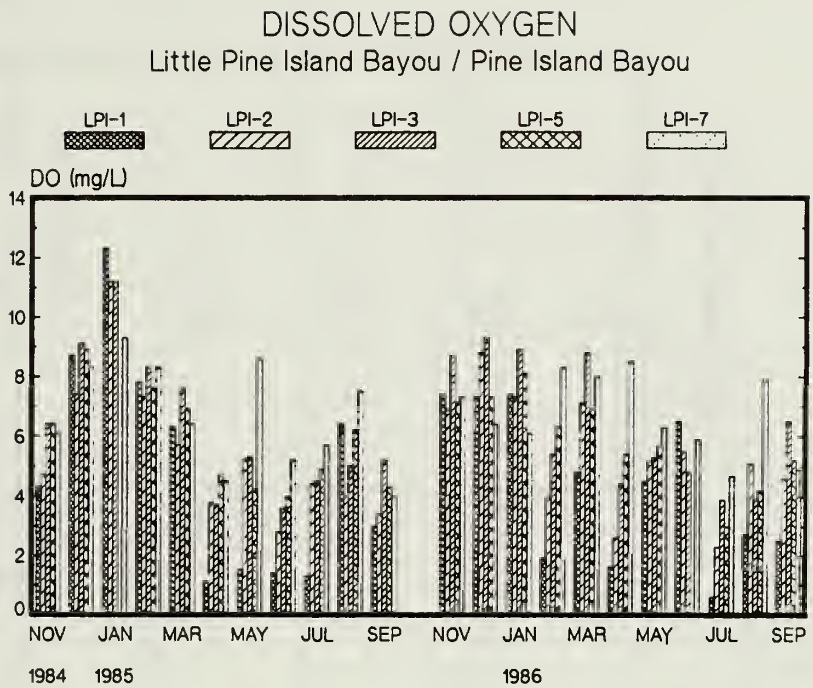

Figure 18. Stream water temperatures for Category 2 stream monitoring sites (November 1984 - November 1986).

Low dissolved oxygen (DO) concentrations were frequently reported for monitoring sites on Little Pine Island Bayou, especially at site LPI-1 (Fig. 19). DO concentrations were below 3.0 mg/L on ten occasions at site LPI-1, with a low of 0.6 mg/L. These low DO concentrations occurred when stream temperatures were high or stream discharge was low. In addition, high fecal coliform counts were occasionally noted at this site (July 1985), suggesting that organic loading may also be contributing to dissolved oxygen stress.

DO concentrations at other sites on Little Pine Island Bayou and Pine Island Bayou were higher than at site LPI-1, although occasional low concentrations (less than 4.0 mg/L) were reported for all sites, especially during low-flow periods. On the other hand, DO concentrations at monitoring sites on Menard Creek were all acceptably high. DO concentrations never fell below 6.0 mg/L at MC-1 or MC-4 during the study period. Texas Water Quality Standards describe a stream maintaining a DO concentration of 6.0 mg/L as being of exceptional quality for aquatic habitat.

Category 2 streams display pH levels (Fig. 20) considered natural for waters in the area. The pH ranged from 5.4 to 7.7 on Little Pine Island Bayou and from 5.9 to 7.0 in Menard Creek. As mentioned previously, the slightly acidic conditions are probably due to the formation of weak organic acids from the decomposition of leaf litter in the streams.

Specific conductance levels were often very high in Little Pine Island Bayou and Pine Island Bayou throughout the sampling period (Fig. 21). In July 1985, an oil brine pipeline rupture at a production well located just upstream from site LPI-1 caused elevated specific conductance levels at many sampling sites. A small drainage ditch on this site carried effluent into Little Pine Island Bayou following the break. The impact on water quality was seen as far downstream as the confluence with Pine Island Bayou (LPI-5) for several months following the incident.



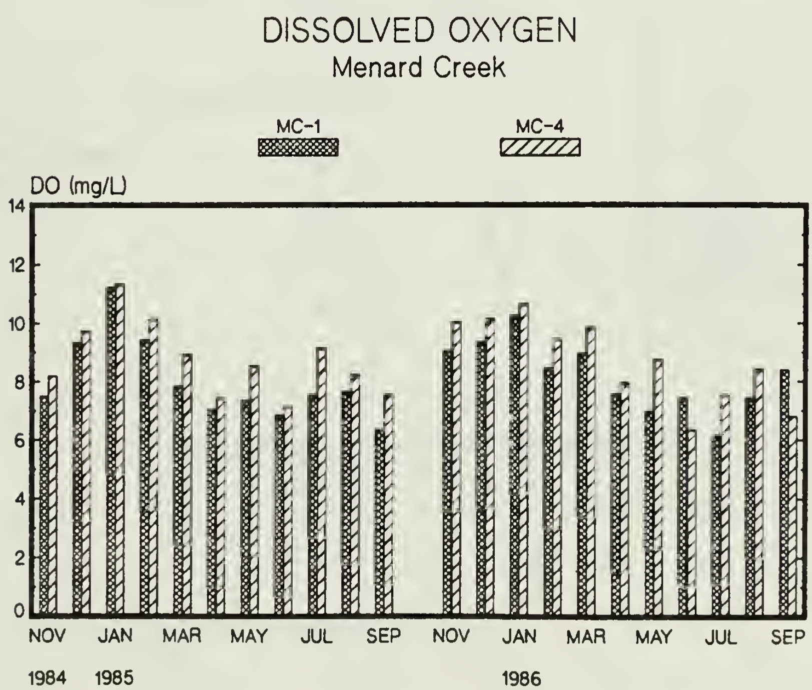




Figure 19. Dissolved oxygen concentrations for Category 2 stream monitoring sites (November 1984 - November 1986).

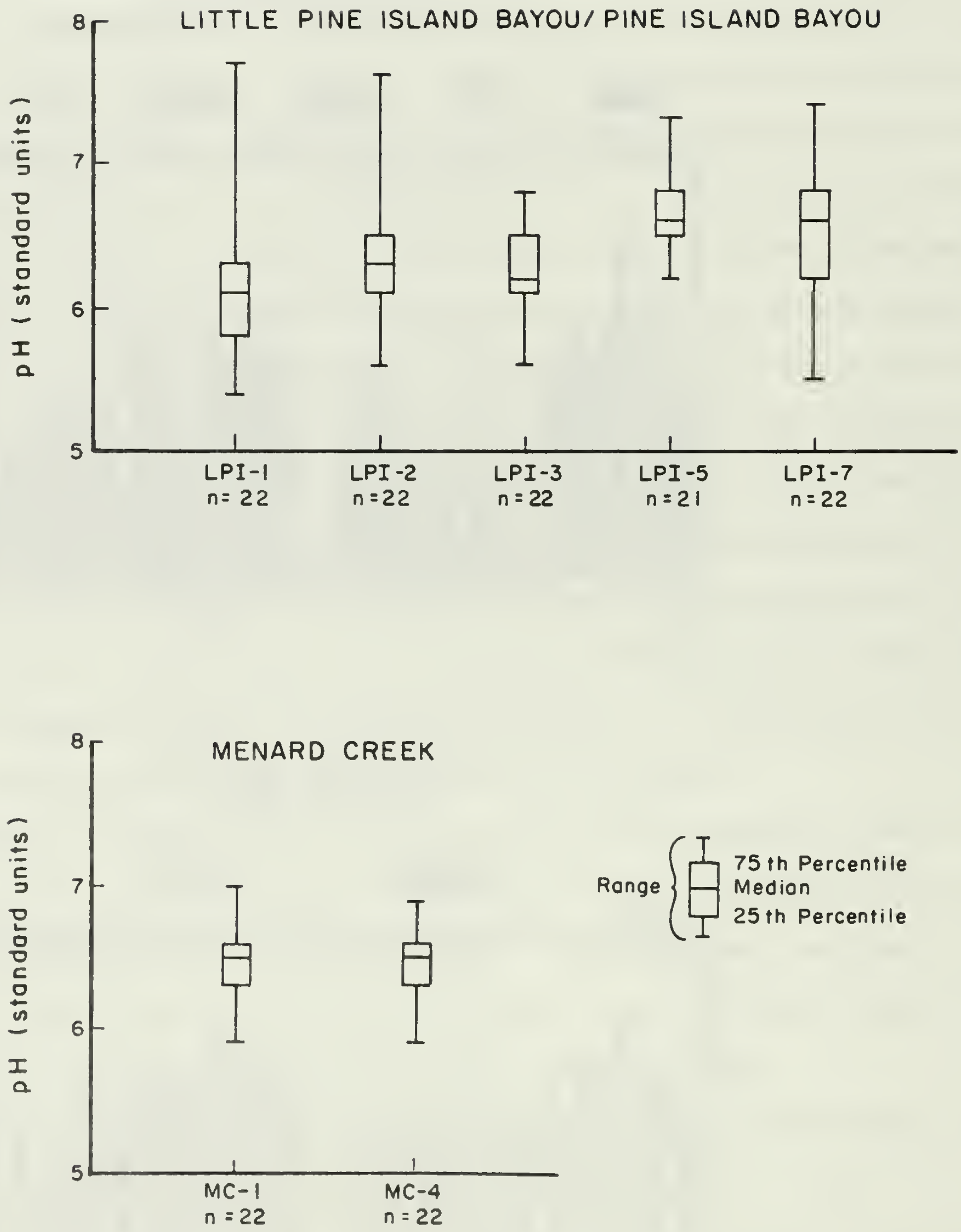



Figure 20. pH medians and ranges for Category 2 streams (November 1984 - November 1986).

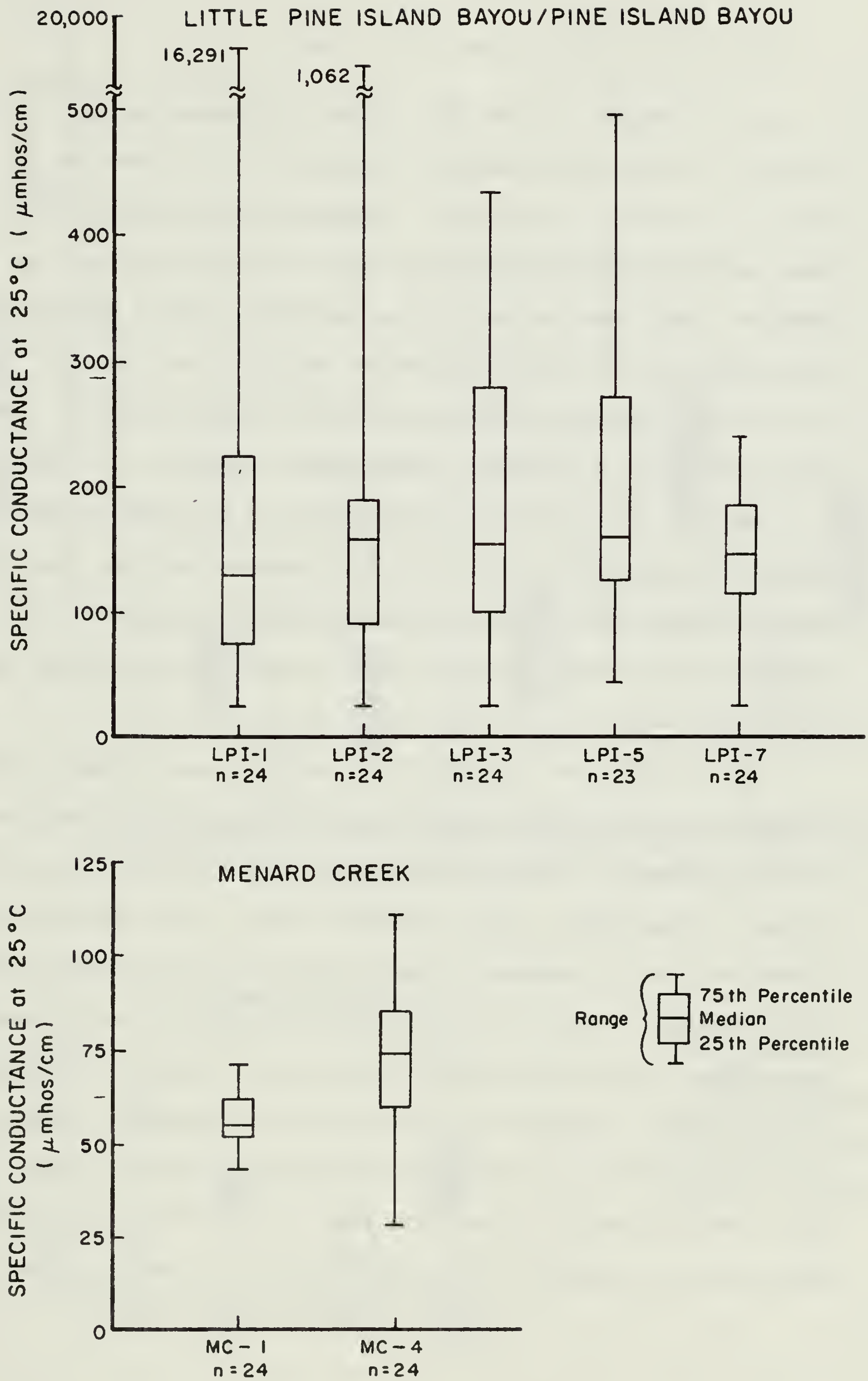



Figure 21. Specific conductance medians and ranges for Category 2 streams (November 1984 - November 1986).

As a result of the oil waste discharge emitted from the faulty pipeline, a specific conductance reading of 16,241 $\mu$mhos/cm was recorded on July 31, 1985 at site LPI-1. Specific conductance at site LPI-1 at this time varied from about 2,000 $\mu$mhos/cm at the water surface to over 16,000 $\mu$mhos/cm near the stream bottom, indicating that a lens of waste material had settled to the bottom and was not mixing in the stream. This gradient in specific conductance was also noted on other occasions. During February 1986 monitoring, a specific conductance reading of 2,300 $\mu$mhos/cm was recorded at site LPI-1 near the bottom in the middle of the stream, while specific conductance at the edge of the stream surface was 155 $\mu$mhos/cm. Several other high specific conductances were recorded in Little Pine Island Bayou and Pine Island Bayou and were thought to be caused by discharges of oil-related wastes.

In contrast to Little Pine Island Bayou, Menard Creek specific conductance values were much lower, ranging from 27 $\mu$mhos/cm to a high of only 111 $\mu$mhos/cm. These values are similar to those observed in Category 1 streams, suggesting that discharges from oil production sites near the stream were not a problem in Menard Creek during the study period.

Turbidity for both Menard Creek and Little Pine Island Bayou is low during high- and low-flow periods (Fig. 22). Below the confluence with Pine Island Bayou, turbidity values are elevated slightly. Median values range from 21 to 60 NTU on Little Pine Island Bayou and Pine Island Bayou during high and intermediate flows, and from 12 to 36 NTU during low-flow periods. Menard Creek turbidity readings were lower, with median values ranging from

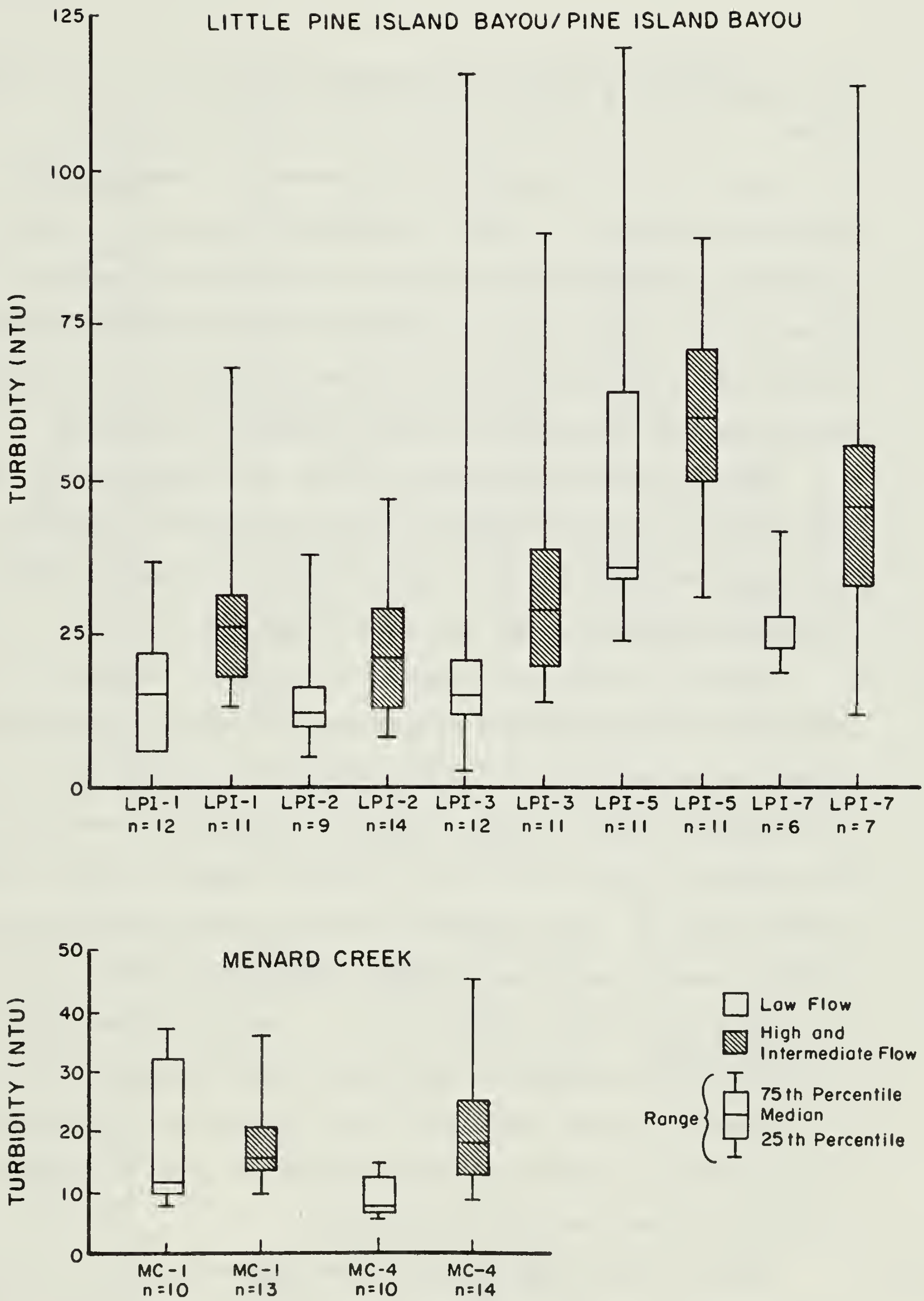



Figure 22. Turbidity medians and ranges during low-flow and intermediate/high-flow conditions for Category 2 streams (November 1984 - November 1986).

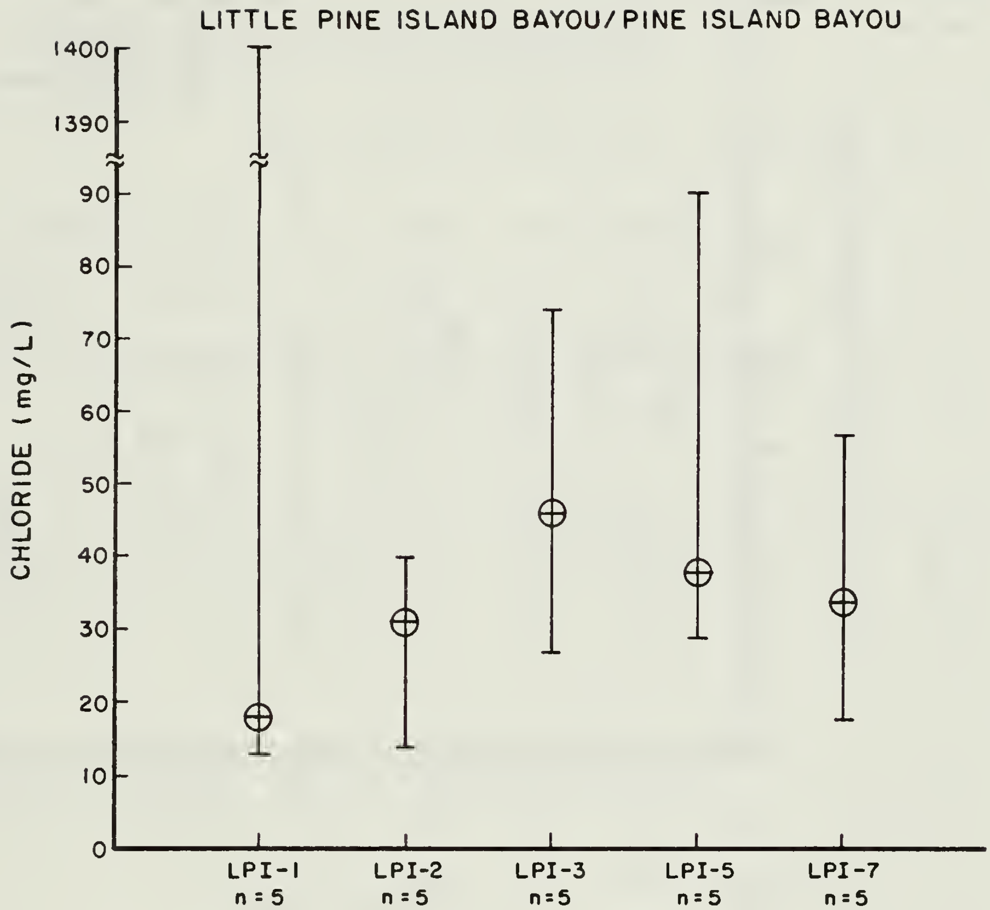
16 to 18 NTU during high and intermediate flows and 8 to 12 NTU in low flows.

Wastes from oil sites have been reported to contain high amounts of chloride compounds in their discharges (Wright et al., 1957), and it was anticipated that sampling occurring in the vicinity of large oil production areas might reflect this. A chloride concentration of 1,400 mg/L reported at site LPI-1 in July 1985 after a brine discharge from an oil operation in the Little Pine Island Bayou watershed supports this finding.

Chloride concentrations (Fig. 23) for the remainder of Little Pine Island Bayou and Pine Island Bayou sites were less than 100 mg/L with median concentrations typically less than 50 mg/L. On Menard Creek, recorded chloride concentrations are less than 25 mg/L for all sites.

Bacteria levels in Category 2 streams displayed considerable fluctuation, with both fecal streptococcus and fecal coliform counts ranging from 20 colonies/100 mL to 2,000 colonies/100 mL (Fig. 24). Little Pine Island Bayou and Pine Island Bayou had the highest bacterial counts, with the geometric mean for fecal coliform ranging between 100 and 200 colonies/100 mL. The geometric mean for fecal streptococcus exhibited a slightly greater range than coliforms, ranging from 72 to 263 colonies/100 mL during the two-year sampling period. Menard Creek bacterial levels were lower than those observed in Little Pine Island Bayou and Pine Island Bayou. The geometric means for both fecal coliform and fecal streptococcus in Menard Creek were near 100 colonies/100 mL, and only two readings for fecal streptococcus exceeded 800 colonies/100 mL.

Table 12 lists means and ranges for alkalinity, color, total suspended solids (TSS), total dissolved solids (TDS), and sulfate. Oil and grease concentrations are not reported because none were above 10 mg/L for any Category 2 site.



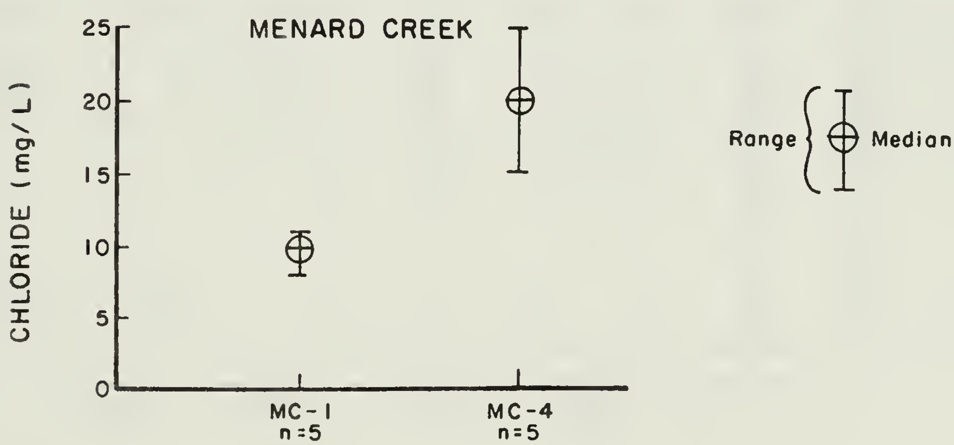




Figure 23. Chloride median concentrations and ranges for Category 2 streams (November 1984 - November 1986).

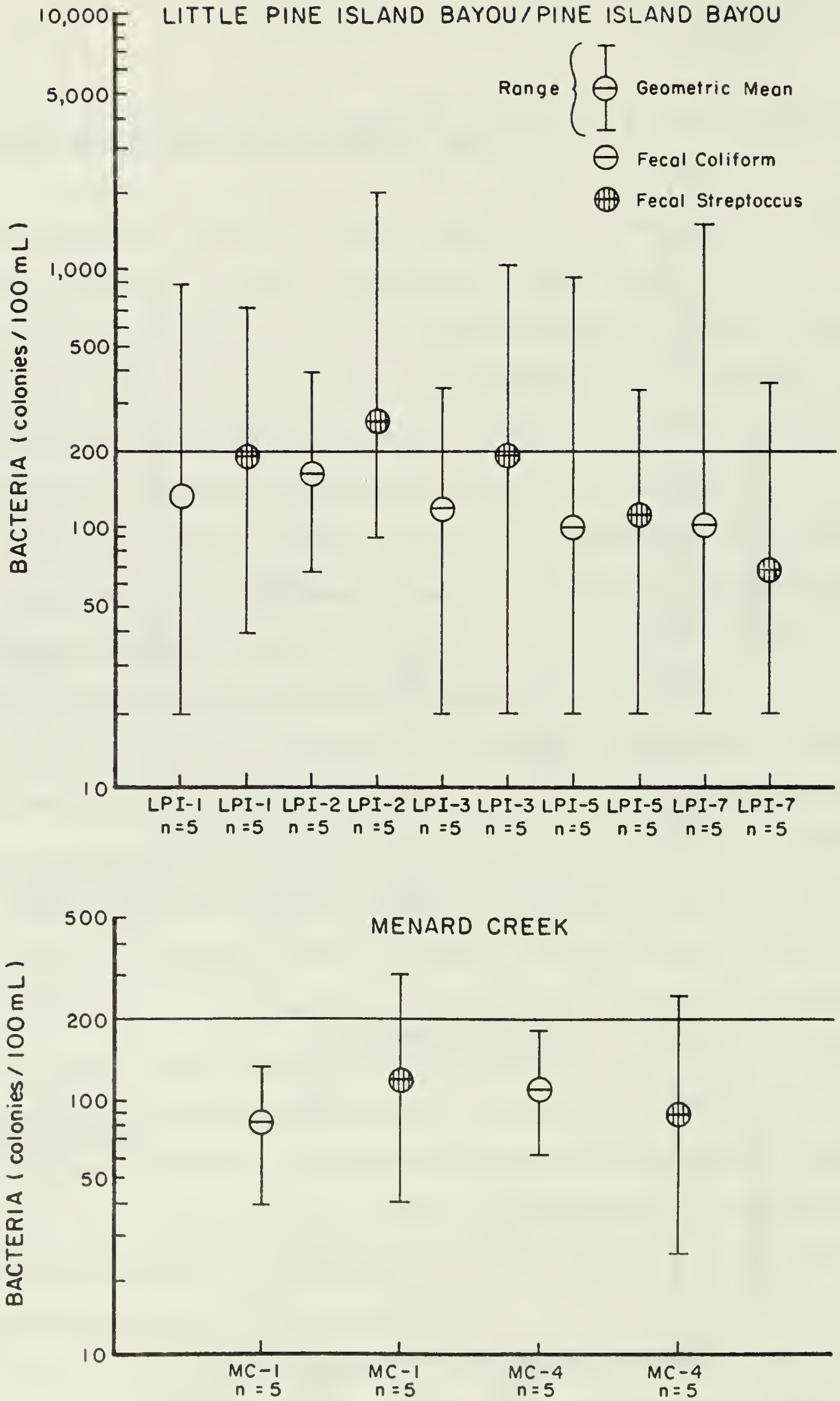



Figure 24. Geometric means and ranges for fecal coliform bacteria and fecal streptococcus bacteria for Category 2 streams (November 1984 - November 1986).

Table 12. Means and ranges for alkalinity, color, total suspended solids (TSS), total dissolved solids (TDS), and sulfate in Category 2 streams (November 1984 - November 1986).

| | | LPI-1 | LPI-2 | LPI-3 | LPI-5 | LPI-7 | MC-1 | MC-4 |
|---|---|---|---|---|---|---|---|---|
| Alkalinity | high | 14 | 20 | 42 | 46 | 30 | 12 | 16 |
| (mg/L as $CaCO_3$) | mean | 8 | 10 | 17 | 33 | 25 | 10 | 12 |
| | low | 4 | 4 | 6 | 20 | 20 | 10 | 10 |
| | n | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Color | high | 275 | 250 | 225 | 175 | 150 | 120 | 100 |
| (Pt-Co units) | mean | 188 | 181 | 150 | 110 | 97 | 80 | 66 |
| | low | 50 | 60 | 45 | 55 | 40 | 60 | 40 |
| | n | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| TSS | high | 23 | 20 | 18 | 34 | 27 | 8 | 47 |
| (mg/L) | mean | 12 | 12 | 12 | 24 | 22 | 6 | 15 |
| | low | 2 | 5 | 6 | 10 | 12 | 4 | 2 |
| | n | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| TDS | high | 2725 | 172 | 222 | 301 | 261 | 96 | 102 |
| (mg/L) | mean | 789 | 148 | 194 | 211 | 183 | 74 | 88 |
| | low | 125 | 116 | 179 | 155 | 111 | 64 | 75 |
| | n | 4 | 5 | 5 | 5 | 5 | 5 | 5 |
| Sulfate (mg/L) (maximum values) | | 30 | 30 | 32 | 24 | 26 | 13 | <10 |

Of the constituents shown, only TDS concentrations are slightly higher than those normally reported for streams in southeastern Texas. High TDS concentrations are related to the oil production site discharges discussed earlier and occurred concurrently with the high chloride and specific conductance levels. Monitoring sites on Little Pine Island Bayou and Pine Island Bayou yielded sulfate concentrations greater than 10 mg/L (as $SO_4$) three times each during the study period. Sulfate concentrations in Menard Creek were usually less than 10 mg/L.

Data Comparisons: U.S. Geological Survey Water Quality Stations

Water quality information was collected at USGS stations on both Menard Creek and Pine Island Bayou during the November 1984 to November 1986 study period (Appendix B). For constituents that were monitored in both USGS and NPS programs, close agreement exists between the two sets of data. U.S. Geological Survey data were compared with data from the closest NPS station. In this case, USGS station 08066300 on Menard Creek was compared with NPS site MC-4, and USGS station 08041700 on Pine Island Bayou was compared with data from NPS site LPI-5.

On Menard Creek, temperature, specific conductance, chloride, sulfate, and TDS were sampled in both monitoring programs. USGS stream temperature readings replicate the seasonal high and low temperatures recorded by the NPS program, with a high of 28°C (82°F) in August 1985 and a low of 10°C (50°F) in January 1985. Specific conductance values are also very similar, with the USGS reporting a mean of 80 μmhos/cm at Menard Creek and the NPS recording a mean of 75 μmhos/cm at site MC-4. Chlorides and TDS concentrations are slightly lower at the USGS station at Menard Creek, which registered a mean chloride concentration of 15 mg/L and a TDS mean of 57 mg/L. This compares to a mean of 20 mg/L for chloride and 88 mg/L of TDS at

NPS site MC-4. Sulfate concentrations are similar, with both monitoring sites reporting mean concentrations below 10 mg/L.

While the USGS and NPS monitoring sites on Menard Creek are at the same location, the USGS station on Pine Island Bayou is located several miles upstream of its confluence with Little Pine Island Bayou. The closest NPS monitoring site below the confluence of Little Pine Island Bayou is LPI-5. LPI-5 is also downstream from the communities of Pinewood Estates and Bevil Oaks, which contribute additional sewage effluents that do not affect the upstream USGS station on Pine Island Bayou.

Temperature, specific conductance, chloride, and sulfate were all similar between the two monitoring sites. The USGS recorded temperatures at Pine Island Bayou within the same seasonal ranges discussed in previous sections. For both the USGS station at Pine Island Bayou and NPS site LPI-5 specific conductance values show a mean of 205 $\mu$mhos/cm for the same time period. Chloride and sulfate mean concentrations are 38 mg/L and 16 mg/L, respectively, at the USGS station, and 47 mg/L and 15 mg/L at the LPI-5 site. Chloride concentrations are slightly higher at the LPI-5 site, possibly due to sewage treatment facilities and oil production wastes discharging into the stream above LPI-5. The NPS also recorded higher TDS mean concentrations (211 mg/L) than the USGS on Pine Island Bayou (119 mg/L). Again, this is most likely related to sewage effluent discharge and oil spills occurring upstream.

### Category 3 Stream

The Neches River in the Upper and Lower Neches River Corridor Units of Big Thicket National Preserve has been classified, for NPS monitoring purposes, as a Category 3 stream. A major waterway with a large drainage basin, the Neches River is regulated and monitored primarily by other

agencies. However, data are collected twice a year by the NPS for comparison with other monitoring stations. At this time, the NPS monitors five sampling sites in the Upper and Lower Neches River Corridor Units of Big Thicket National Preserve, and the USGS maintains a monitoring station (0804100) on the Neches River, located at Evadale, TX.

## Stream Description

The Big Thicket National Preserve units along the Neches River extend for 157 km (98 miles) from the outlet of B.A. Steinhagen Lake to the bottom of the Beaumont Unit, just north of the city of Beaumont (Fig. 25). Included in this area are four management units: the Upper Neches River Corridor Unit, the Neches Bottom and Jack Gore Baygall Unit, the Lower Neches Corridor Unit, and the Beaumont Unit.

The predominant land use adjacent to Big Thicket National Preserve along the Neches River is commercial timber harvesting. With the exception of a few interspersed rural homesites, the entire Upper Neches Corridor Unit is bordered by timber operations. These timber areas include clearcut land as well as stands of mature trees. In addition to rural homesites and extensive timber-cutting areas, the Neches Bottom and Jack Gore Baygall Unit may be affected by a few oil and gas production fields near the preserve boundaries and individual wells within the management unit. Adjacent to the Beaumont Unit, the land use is primarily residential in nature, with less timber harvesting and a few oil production sites.

The Neches River is a large river system with many tributary streams. Consequently, other agencies concerned with water quality, such as the USGS, the Lower Neches Valley Authority, and the State of Texas, monitor the river on a regular basis. Since the river has abundant water quality data available, the NPS samples the Neches River semiannually for comparative

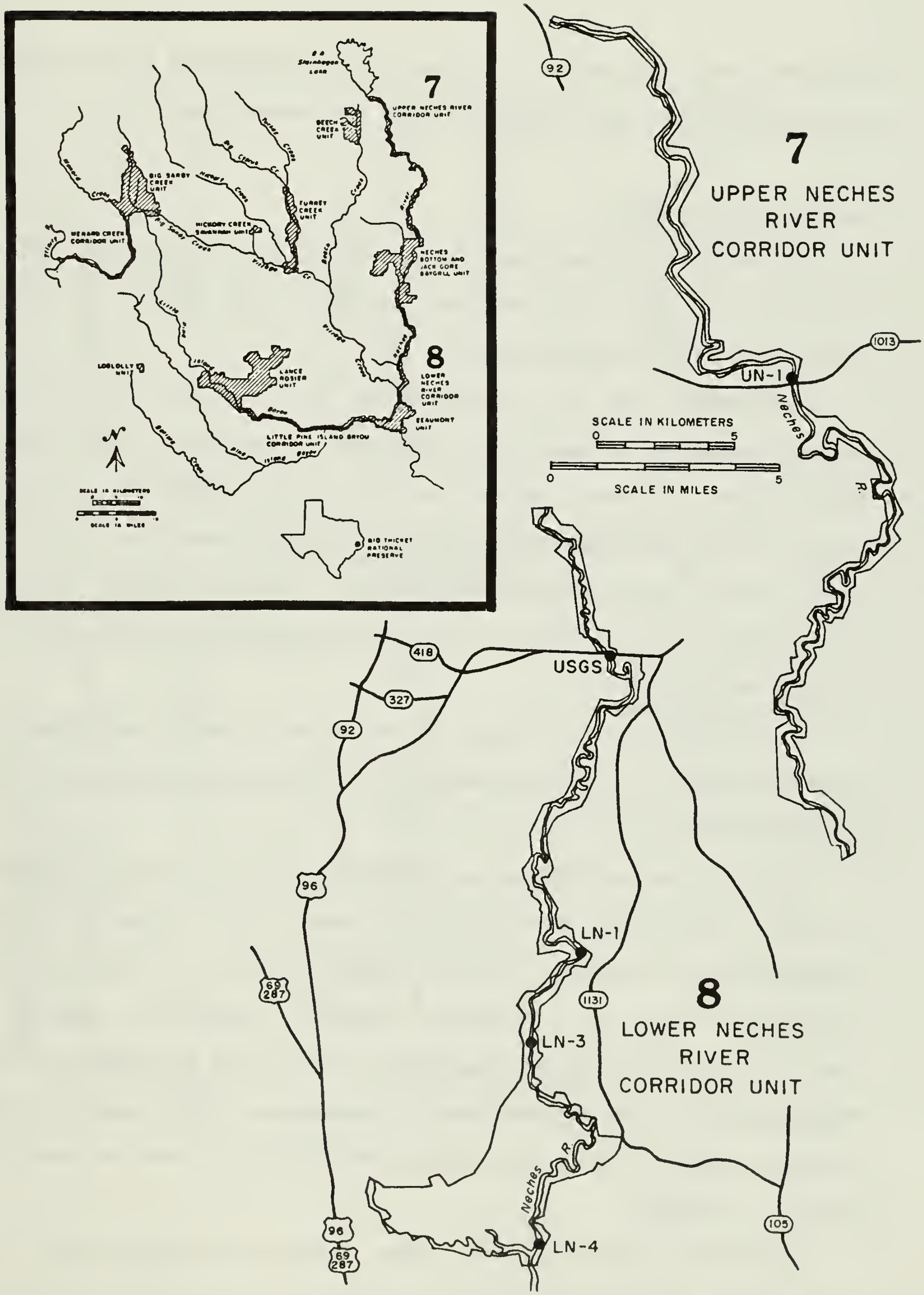



Figure 25. Locations of monitoring stations for the Category 3 stream in Big Thicket National Preserve, Texas.

purposes only and relies on other agency information for the bulk of the water quality data base established for the Neches River.

Water Quality Summary

Because the USGS data base for the Neches River is considerably greater than that of the NPS, USGS data is used in this section to describe the water quality of the Neches River.

Temperature and DO concentrations vary little from the patterns established in the Category 1 and Category 2 streams. Even though the Neches River is much larger than the other streams in the Big Thicket region, stream temperatures were similar, ranging from 8o to 30°C (46° to 86°F) during the 1984-86 sampling period. Dissolved oxygen concentrations did not drop as low, however, with all DO concentrations exceeding 7.5 mg/L at USGS station 0804100.

At the USGS site, pH values are within the limits designated by the State of Texas for river segment 0602 (6.0-8.5 pH units) with a median pH level of 6.6 (Fig. 26).

Chloride concentrations are acceptable, with all levels reported below 50 mg/L, the Texas Water Quality Standard for chloride. Chloride concentrations fluctuated little, ranging from 12 to 27 mg/L with a median of 21 mg/L (Fig. 26). Likewise, specific conductance remained fairly consistent, with a high of 173 μmhos/cm and a low of 109 μmhos/cm during the sampling period. The median specific conductance is 154 μmhos/cm, which is slightly higher than other median conductivities found on Category 1 and Category 2 streams.

Turbidity values in the Neches River are consistent with the other streams in the Big Thicket area. Flow quantities did not seem to affect turbidity noticeably, with all turbidities below 40 NTU.

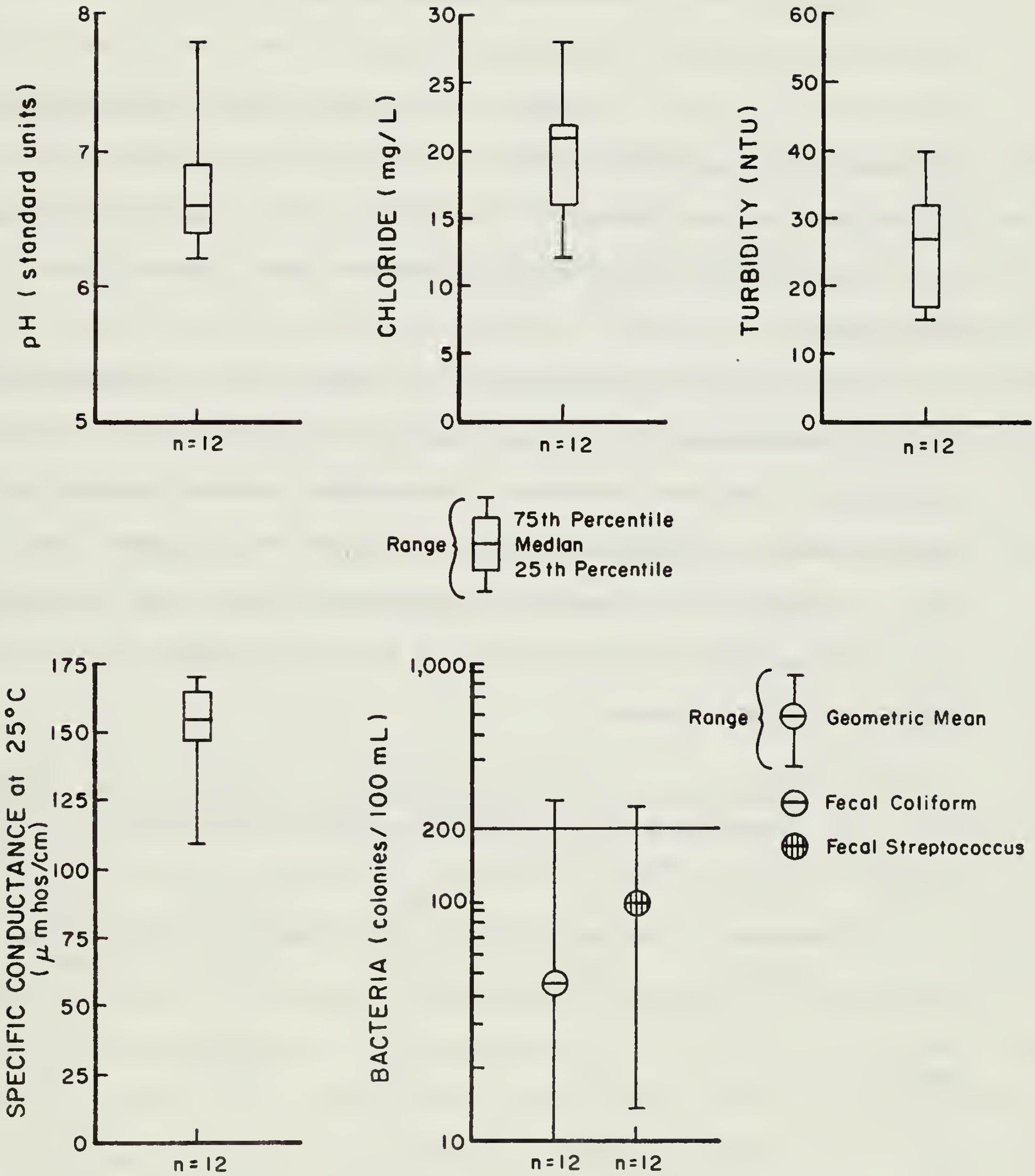



Figure 26. pH, chloride, turbidity, specific conductance, and bacterial monitoring data for USGS station 0804100 (Neches River at Evadale, TX) November 1984-November 1986.

Concentrations of bacteria in the Neches River were also low throughout the sampling period. The geometric mean for fecal coliform is 47 colonies/100 mL, and for fecal streptococcus it is 100 colonies/100 mL. Both geometric means are lower than those found in many of the smaller streams of Big Thicket National Preserve. The fecal coliform concentrations are well below the Texas Water Quality Standard of 200 colonies/100 mL for contact recreation.

Other parameters collected at the USGS station are summarized in Table 13. All concentrations for each constituent are within the range considered normal for the area, although a few sulfate readings approach or equal the state standard of 30 mg/L. Nutrient data and metal concentrations for the USGS station are presented in Appendix B. Again, most concentrations are low, with occasional high readings of iron and manganese. The cause for the high readings is unknown.

Table 13. Means and ranges of water quality parameters from the USGS monitoring station 0804100, Neches River at Evadale (1984-1986).

| | Na dissolved mg/L | Ca dissolved mg/L | Mg dissolved mg/L | K dissolved mg/L | Si dissolved mg/L |
|---|---|---|---|---|---|
| High | 19 | 9 | 3.6 | 3.7 | 15 |
| Mean | 16 | 8 | 3.1 | 3.0 | 11 |
| Low | 11 | 7 | 2.1 | 2.6 | 8 |
| n | 12 | 12 | 12 | 12 | 12 |

| | $SO_4$ dissolved mg/L | Hardness total mg/L | Alkalinity total mg/L | TDS mg/L | TSS mg/L |
|---|---|---|---|---|---|
| High | 30 | 35 | 25 | 110 | 147 |
| Mean | 24 | 32 | 17 | 95 | 46 |
| Low | 18 | 26 | 10 | 79 | 15 |
| n | 12 | 12 | 12 | 12 | 12 |

# DISCUSSION

## Comparison with Previous Studies

Recent reports (Flora et al., 1985; Hughes et al., 1986) have summarized available water quality information on Big Sandy Creek, Beech Creek, Turkey Creek, Menard Creek, Little Pine Island Bayou and Pine Island Bayou within Big Thicket National Preserve. However, different methods and instrumentation are used for the determination of certain constituents between earlier studies and the present NPS monitoring program. These differences and when they may influence the results are mentioned in the following discussion. Therefore, this comparison, while intended to be informative, should be viewed as only approximate in nature.

Stream temperatures in the preserve exhibit similar annual fluctuations for all waters when compared with the previous studies. Temperatures recorded by the NPS are slightly higher, but not significantly so, and seasonal low temperatures are consistent at all sites with those previously recorded. Dissolved oxygen concentrations for Big Sandy Creek, Menard Creek, Turkey Creek, and Village Creek are similar to concentrations found in previous studies. However, DO concentrations reported for Beech Creek and Little Pine Island Bayou during the summer of 1985 are lower than those found in previous studies and include more readings under 5.0 mg/L. Natural conditions may explain these differences: although precise flow information was not recorded for Beech Creek or Little Pine Island Bayou during this sampling period, discharge records from the USGS report below-average discharges during the summer of 1985. These dry conditions combined with warm summer temperatures probably contribute to the low DO concentrations observed in Beech Creek and Little Pine Island Bayou. Turbidity measurements from previous studies are higher than those reported by the NPS

for both high and low flows for all sampling sites (Fig. 27). While it is possible that turbidity has decreased over the years, a more likely explanation for the different readings is the dissimilar equipment used in the studies. The previous studies used a spectrophotometer, which measures turbidity in Jackson Turbidity Units (JTU), while the present program uses a turbidimeter, which measures turbidity in Nephelometric Turbidity Units (NTU). While JTU and NTU are roughly equivalent, the optical properties of the instruments differ enough to make comparisons approximate at best.

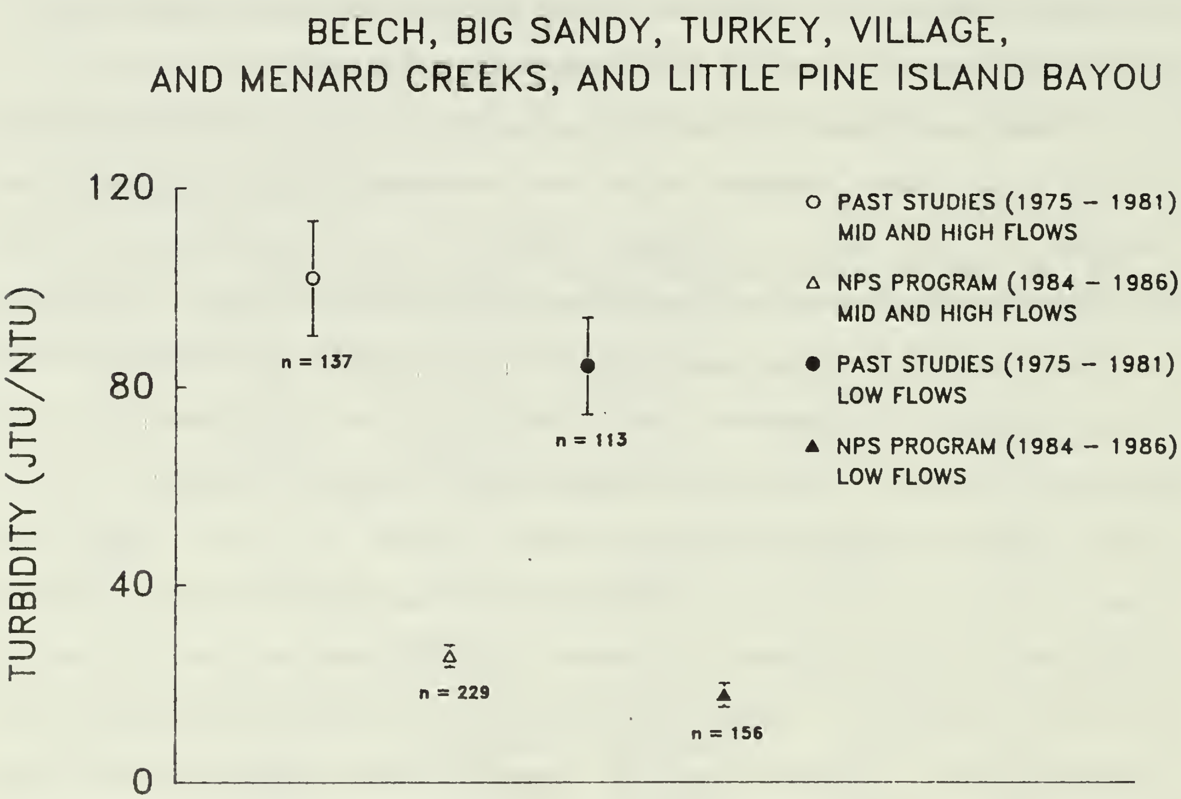



Figure 27. Comparison of turbidity data (means and 95% confidenc intervals) from previous studies and the present program at Beech Creek, Big Sandy Creek, Turkey Creek, Village Creek, Menard Creek, and Little Pine Island Bayou monitoring sites.

Slightly lower pH values were observed during the previous studies than were recorded in the 1984-1986 study (Fig. 28). Menard Creek and Big Sandy Creek show differences of about 0.5 pH units between median values for each study. Again, the most likely explanation for the minor differences in pH readings can be attributed to instrumentation or changes in natural conditions during the study periods. However, the data should be evaluated periodically to identify water quality trends. Specific conductance values in the present study are generally lower than those of earlier studies (Figs. 29, 30, 31). In many cases the decreases in Menard Creek (Fig. 29),

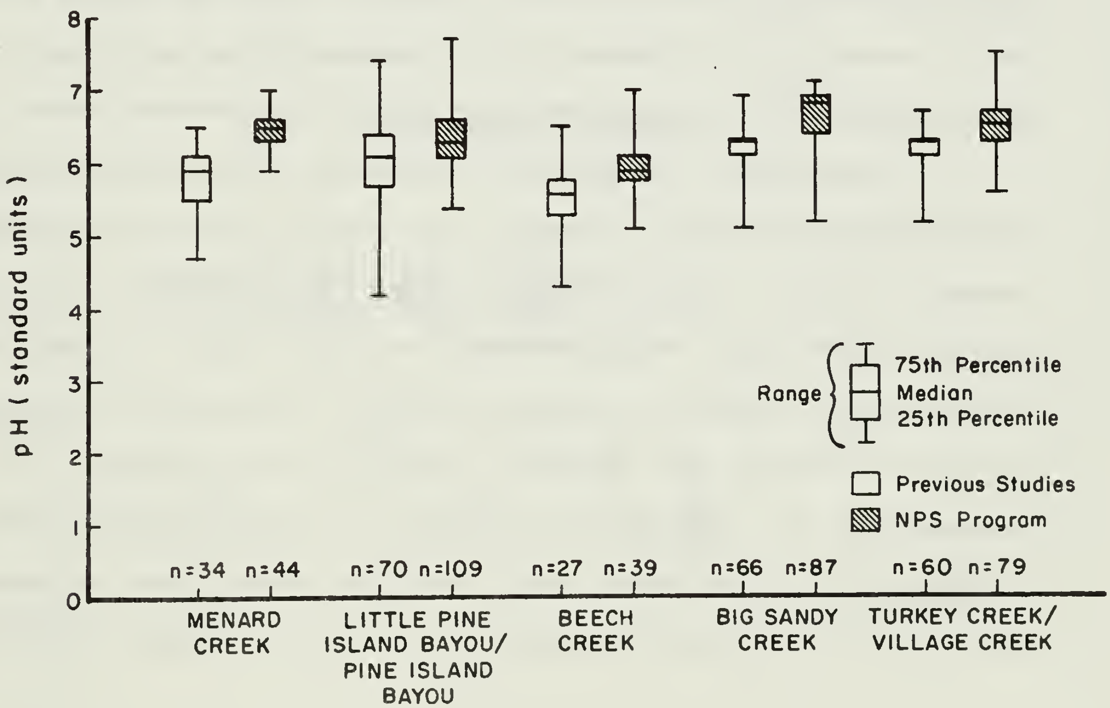



Figure 28. Comparison of pH data from earlier studies with the present program at Menard Creek, Little Pine Island Bayou, Pine Island Bayou, Beech Creek, Big Sandy Creek, Turkey Creek, and Village Creek monitoring sites.

Turkey Creek, and Village Creek (Fig. 30) are significant, and they may be attributed to a decline in oil and gas production from the Schwab oil field as well as greater environmental control at oil fields just upstream from the monitoring sites. Site LPI-1 on Little Pine Island Bayou displays higher mean values of specific conductance with larger 95% confidence intervals than during earlier studies (Fig. 31). This is due to a few very high specific conductance readings caused by the ruptured pipeline. Analysis of chloride concentrations between previous and present study efforts yields results similar to those found for specific conductance. Chloride concentrations from 1975-1978 are slightly higher than concentrations found during 1984-1986 in Beech Creek (Fig. 32) and in Turkey Creek and Village Creek (Fig. 33). Figure 34 shows the effect of the brine spill above LPI-1, although chloride concentrations are lower in the 1984-1986 monitoring than in previous studies at the downstream sites.

As demonstrated in Figure 35, bacterial levels for fecal coliform and fecal streptococcus have changed very little from previous studies to present levels. Data collected during the 1975-1981 period exhibits slightly higher peak concentrations for both fecal coliform and fecal streptococcus bacteria at several sites, but the geometric means for fecal coliform bacteria are generally within state standards for contact recreation. The remaining constituents sampled in both past and present studies, such as alkalinity, total dissolved solids, total suspended solids, and color, were found to be similar or to have negligible differences.

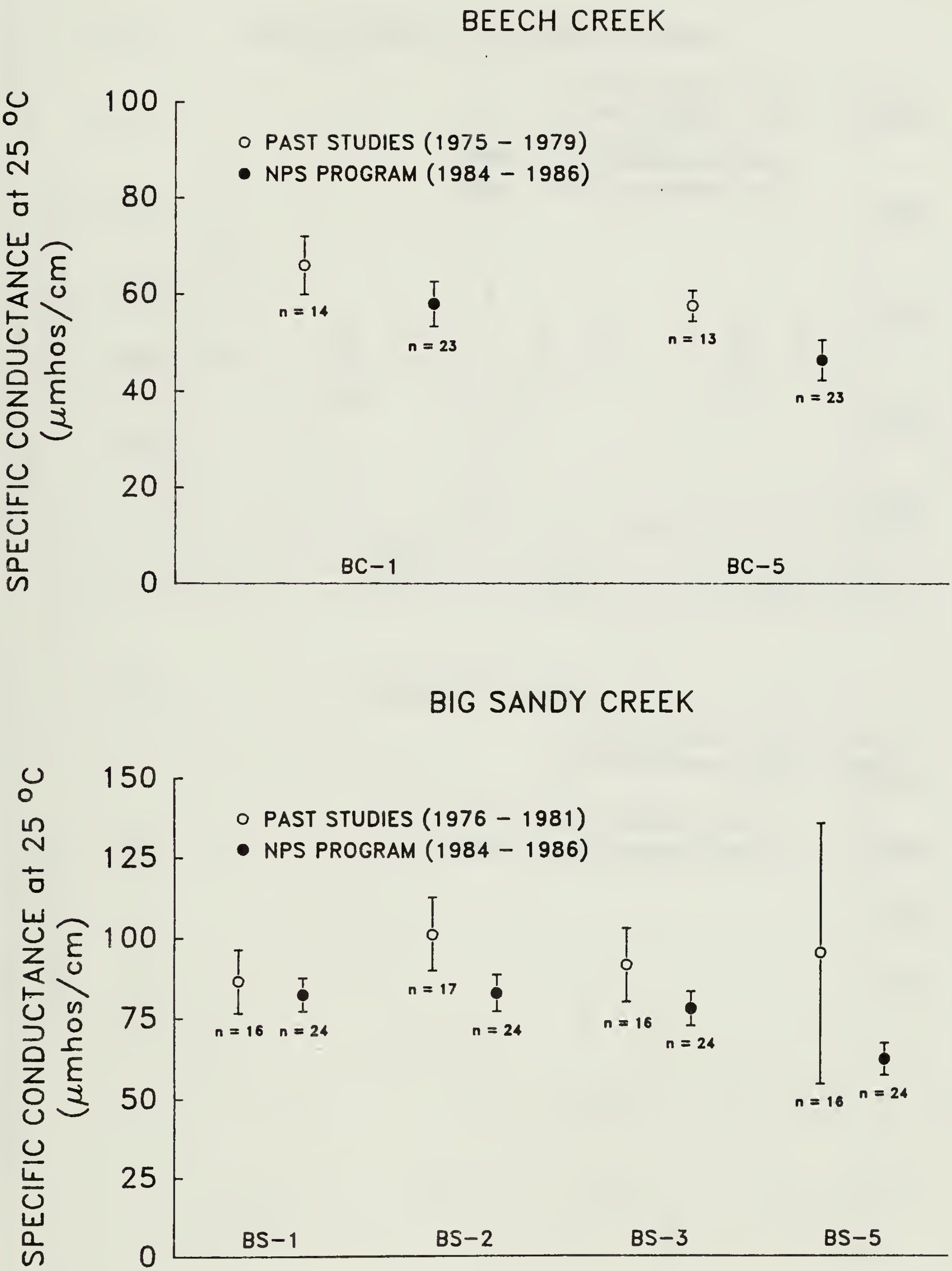



Figure 29. Comparison of specific conductance data (means and 95% confidence intervals) from earlier studies with the present program at Beech Creek and Big Sandy Creek monitoring sites.

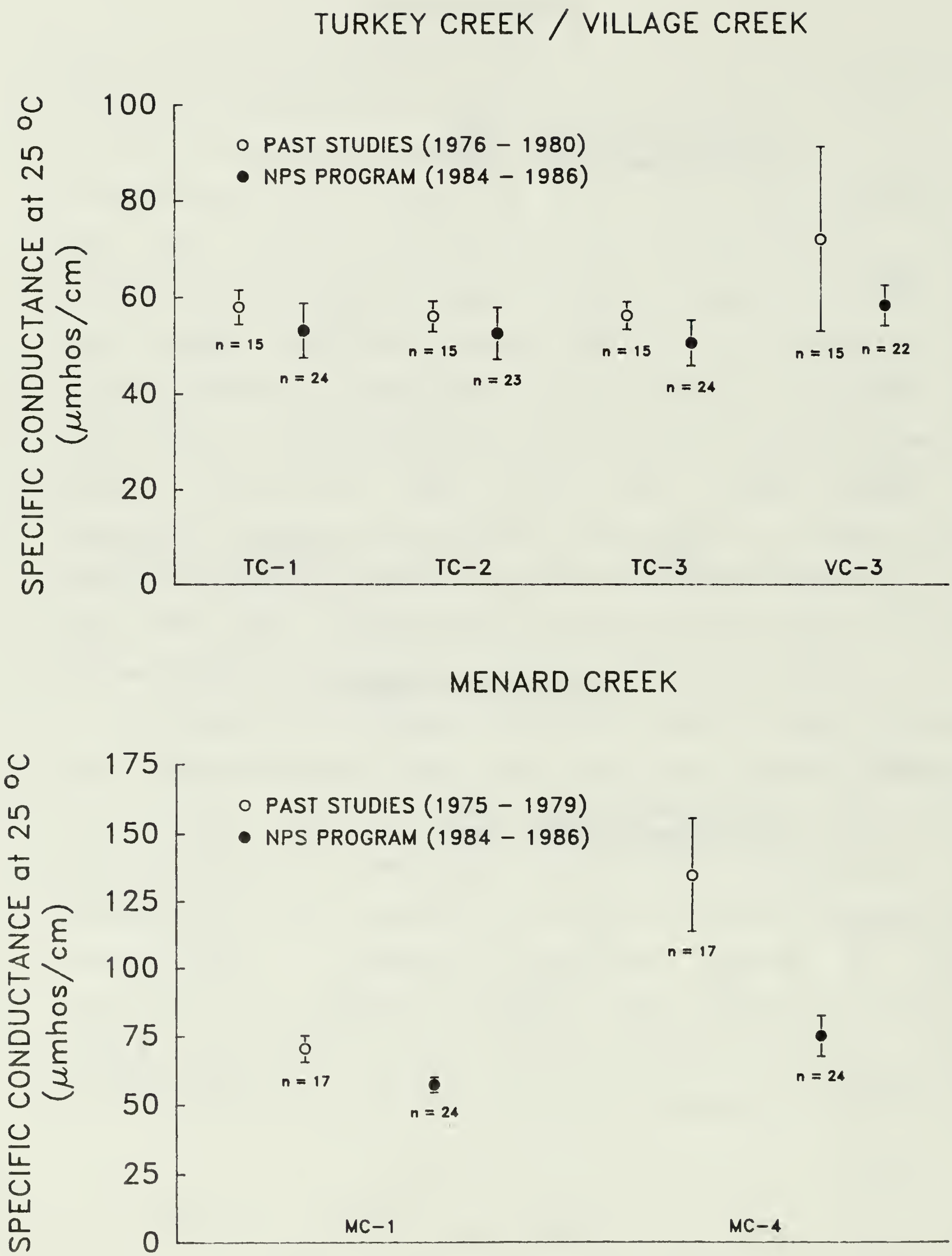



Figure 30. Comparison of specific conductance data (means and 95% confidence intervals) from earlier studies with the present program at Turkey Creek, Village Creek, and Menard Creek monitoring sites.

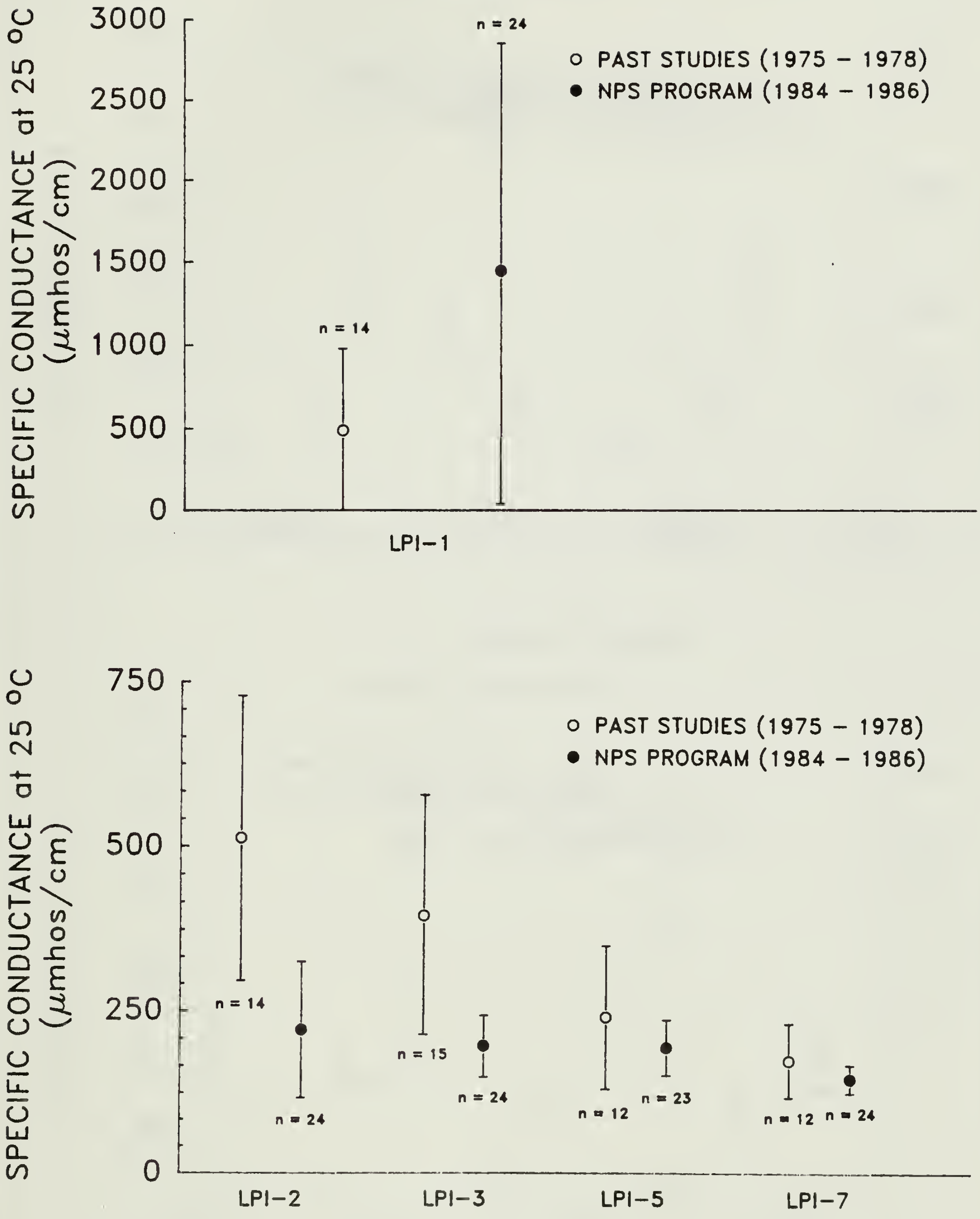



Figure 31. Comparison of specific conductance data (means and 95% confidence intervals) from earlier studies with the present program at Little Pine Island Bayou and Pine Island Bayou monitoring sites.

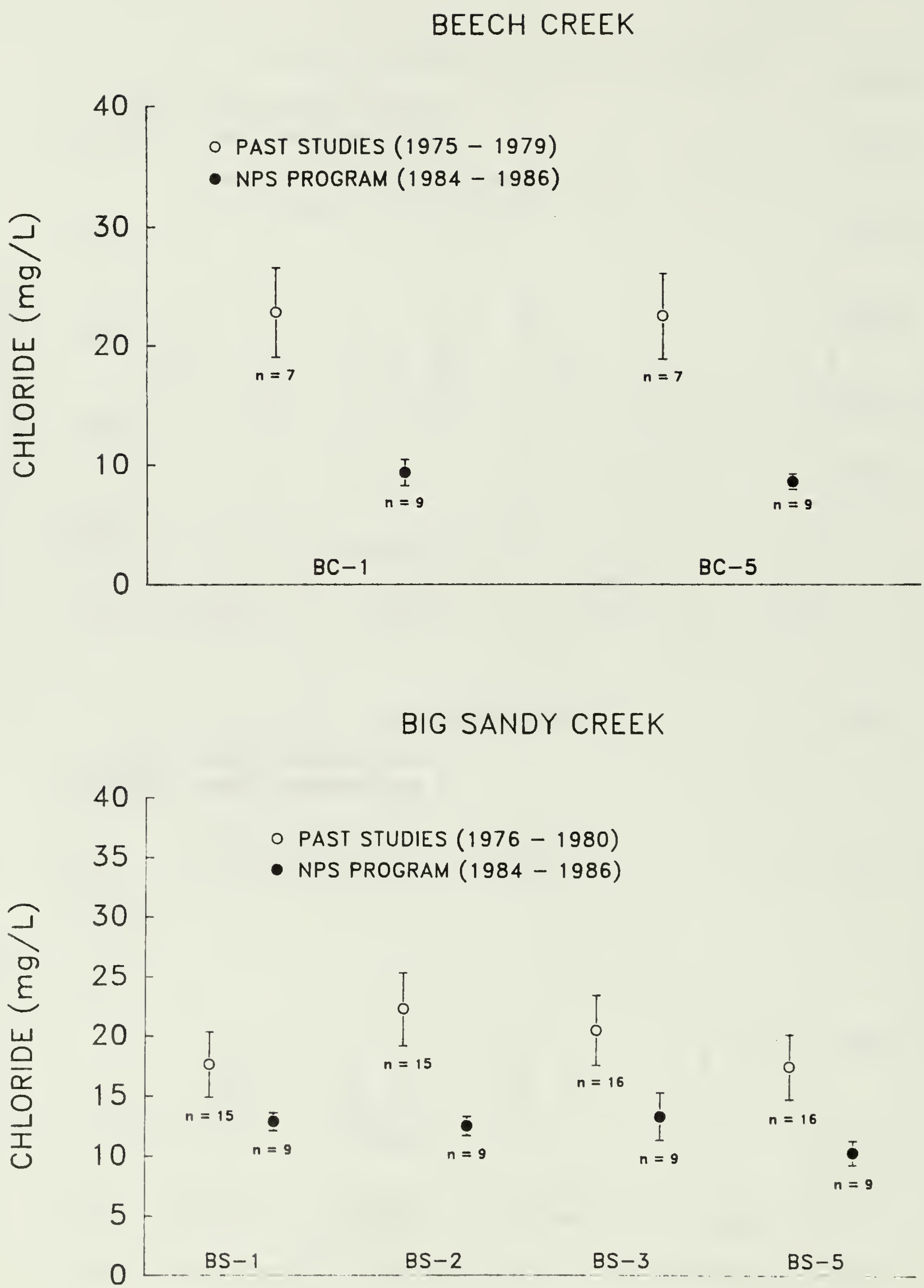



Figure 32. Comparison of chloride data (means and 95% confidence intervals) from earlier studies with the present program at Beech Creek and Big Sandy Creek monitoring sites.

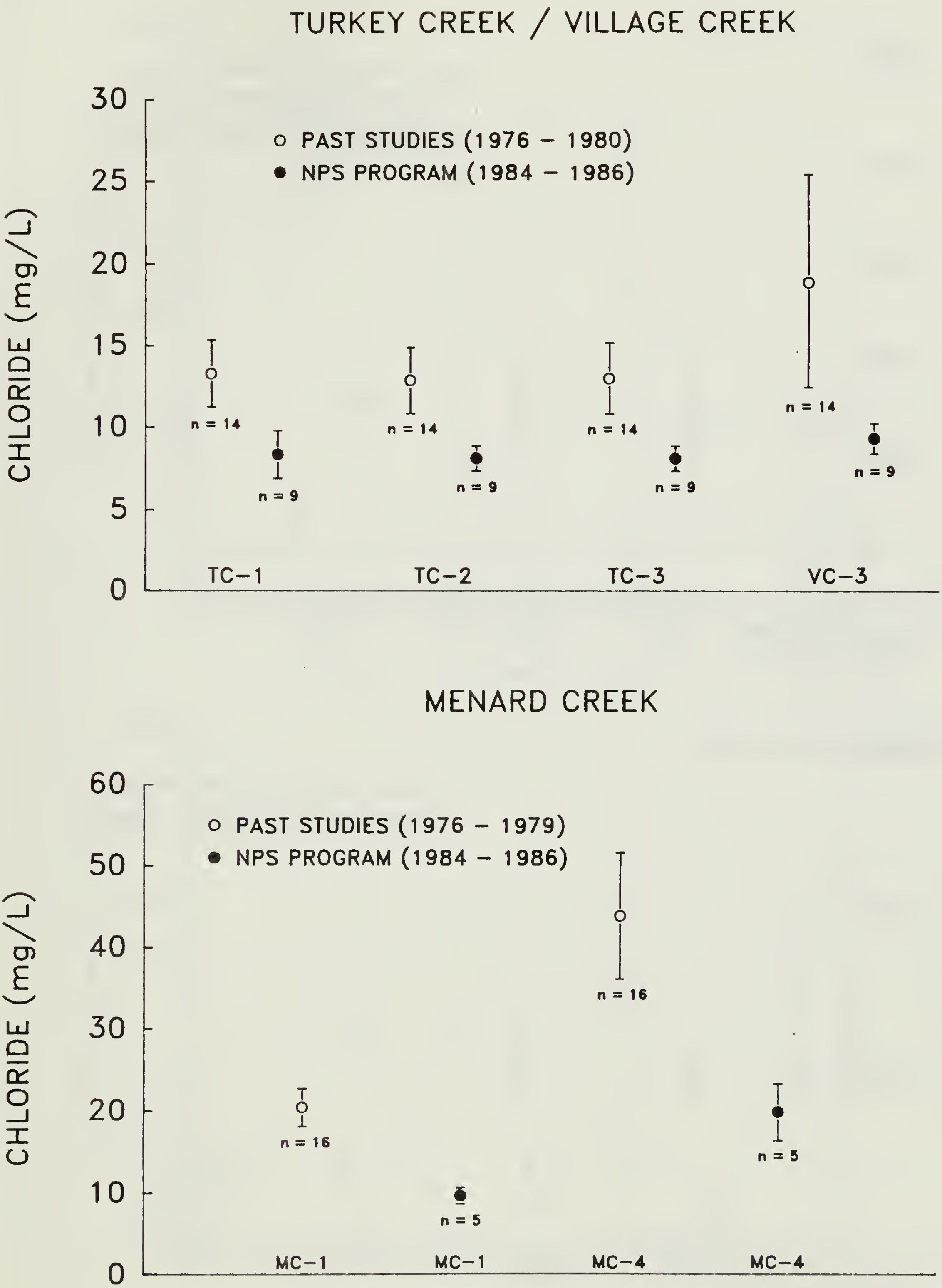



Figure 33. Comparison of chloride data (means and 95% confidence intervals) from earlier studies with the present program at Turkey Creek, Village Creek, and Menard Creek monitoring sites.

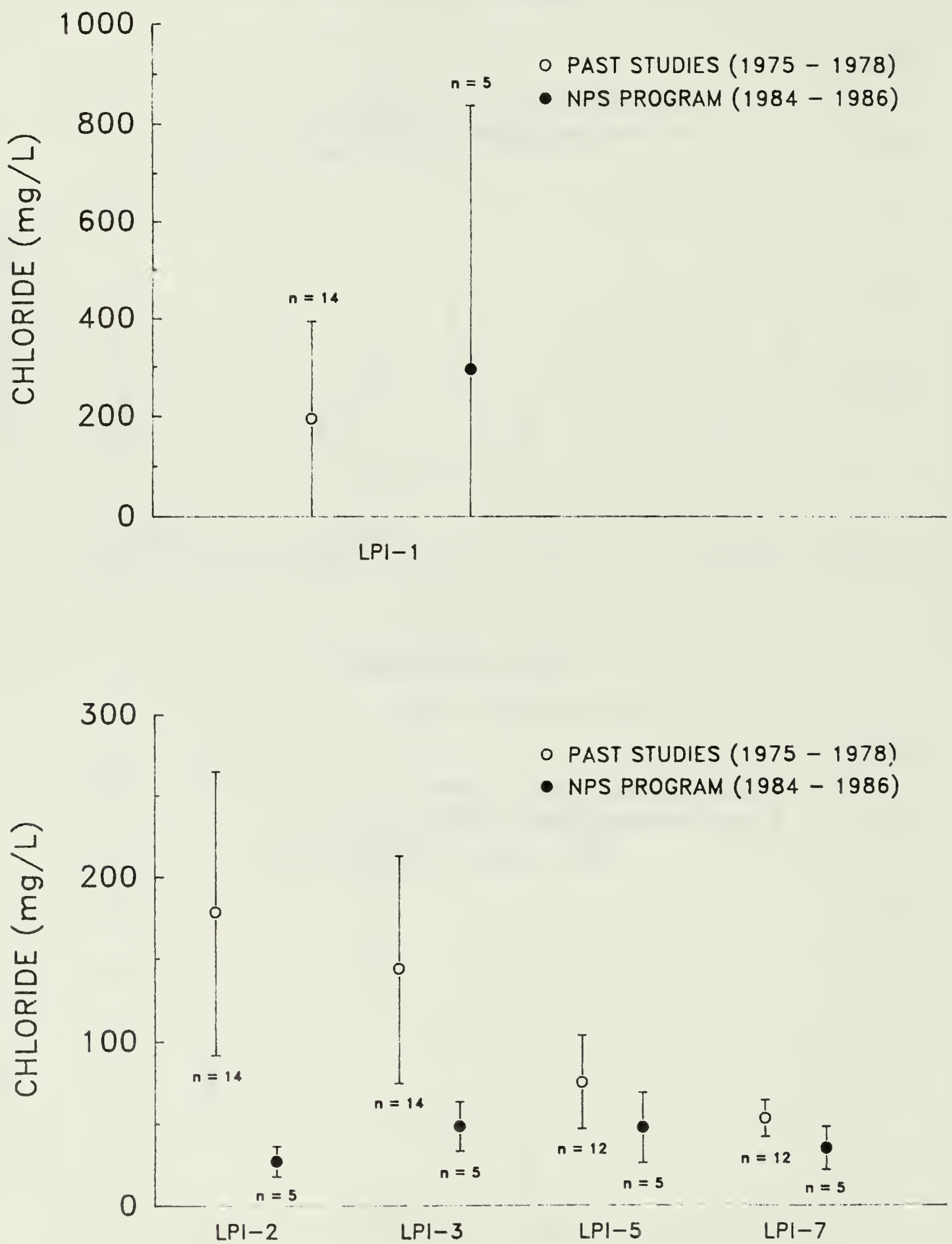



Figure 34. Comparison of chloride data (means and 95% confidence intervals) from earlier studies with the present program at Little Pine Island Bayou and Pine Island Bayou monitoring sites.

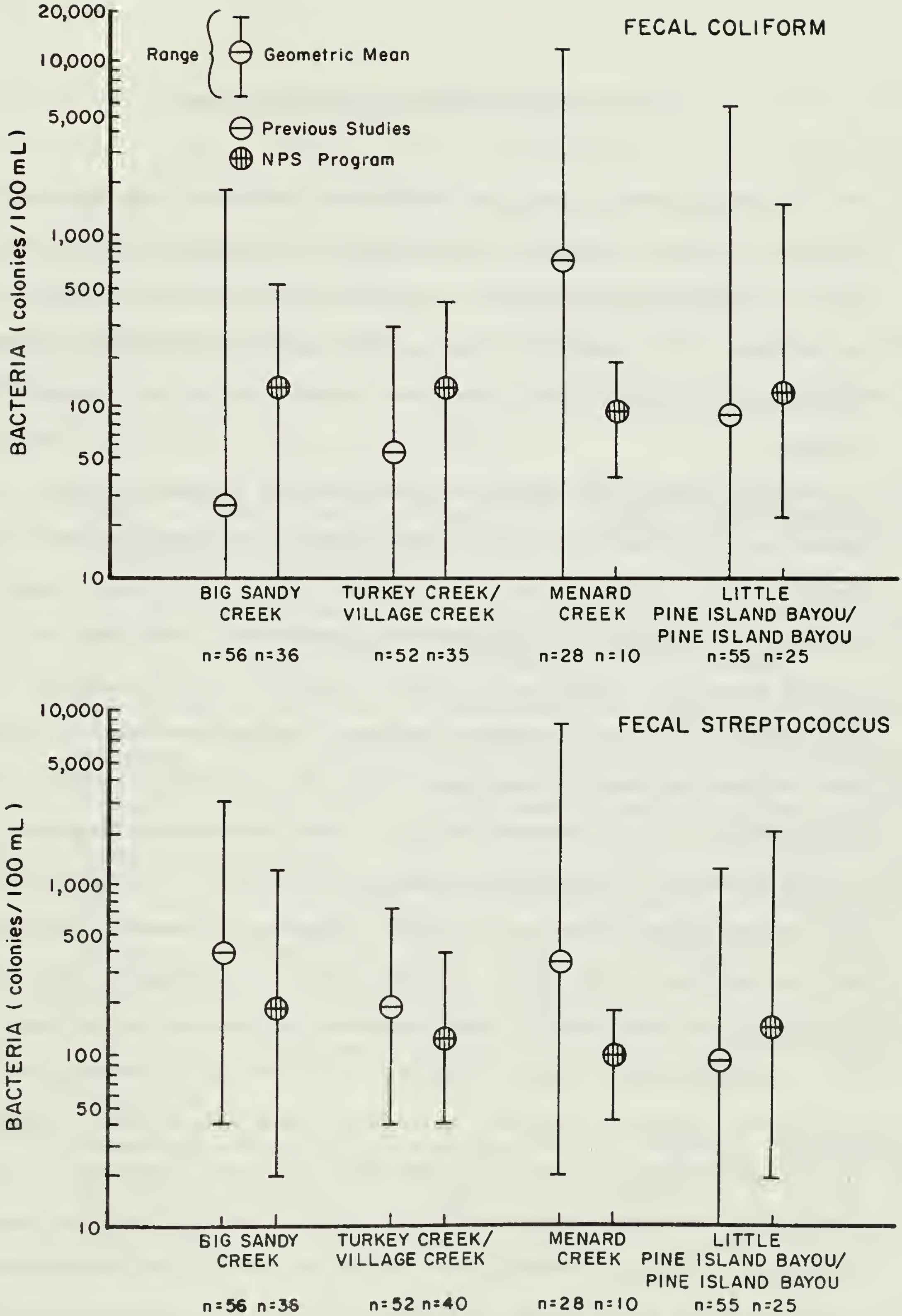



Figure 35. Comparison of fecal coliform bacteria data and fecal streptococcus bacteria data from earlier studies with the present program at Big Sandy Creek, Turkey Creek, Village Creek, Menard Creek, Little Pine Island Bayou and Pine Island Bayou monitoring sites.

## CONCLUSIONS AND RECOMMENDATIONS

The 1984-1986 water quality monitoring program of Big Thicket National Preserve has been a success in providing both background water resource data and in detecting water quality impacts resulting from adjacent land-use activities. In general, water quality problems documented in the present monitoring program are consistent with those found in the Lamar University studies.

Based on the constituents monitored in the present program, the best water quality can be found in the Category 1 streams of Beech Creek, Big Sandy Creek, Turkey Creek, and Black Creek. Village Creek, also a Category 1 stream, and Category 2 streams Menard Creek and the Little Pine Island Bayou/Pine Island Bayou system continue to be affected by oil field activities and small amounts of organic loading attributed to recreational and residential housing development. Of the affected streams, the data indicate that Menard Creek and Village Creek are slightly degraded while the Little Pine Island Bayou/Pine Island Bayou system is moderately degraded. The water quality of the Neches River (Category 3) from B.A. Steinhagen Lake to the confluence with Pine Island Bayou is generally good and meets standards for high-quality aquatic habitat and contact recreation.

A comparison of water quality data collected during the present monitoring program (1984-1986) with data from previous studies suggests that the overall water quality in Big Thicket National Preserve is generally improving for the constituents monitored. However, serious water quality problems relating to specific oil activities remain, as evidenced by the brine spill in Little Pine Island Bayou. Because of the widespread presence of these activities, and ongoing timber operations and watershed development adjacent to the boundaries of Big Thicket National Preserve, the

continuation of water quality monitoring is recommended to ensure resource protection. In addition, the establishment of stream-specific antidegradation standards should be considered as part of the Texas State Water Quality Standards when an adequate data base is available (FY 89-90).

While the present monitoring program has been responsive to the water quality needs recognized in 1984, an evaluation of the data and more recent information indicate that there are areas that should be considered for program improvement. These areas include:

- The amount of discharge data collected in the first two years of the study is less than necessary for complete data interpretation. Discharge data should be collected at a minimum of one site on each creek during each sampling trip.

- Biological Oxygen Demand (BOD) should be included and sampled with the other laboratory parameters. The BOD results can be used to estimate the amount of waste discharges into the streams.

- The consensus opinion at a recent workshop regarding the regulatory identification of petroleum hydrocarbons (U.S. Army Corps of Engineers, 1987) indicated that the currently used "oil and grease" parameter does not provide adequate information to accurately evaluate the potential for environmental impact in water containing a mix of hydrocarbons. It was generally agreed that polycyclic aromatic hydrocarbons (PAH) are the class of hydrocarbons most likely to be of environmental consequence. The low molecular weight PAH, while not persistent in the environment, are acutely toxic. Higher molecular weight PAH may result in chronic toxicity in some organisms, accumulating and persisting in the tissues. While it is not suggested that the PAH be added to the present monitoring program (because of cost), the limitations of the "oil and grease" parameter should be recognized. The availability of local laboratory facilities capable of PAH analysis should be investigated, should a severe oil spill require intensive follow-up monitoring.

- Information about pesticide application on adjacent silvicultural lands and rice fields is lacking. Certain pesticides, thought to be applied regionally on rice crops, are of concern to the U.S. Fish and Wildlife Service. Liaison between the NPS and U.S. Fish and Wildlife Service is encouraged to discuss the need for specific studies relating to pesticide contamination.

- A land-use map is needed for the Big Thicket region which would locate agricultural, oil and gas, and forestry activities as well as communities with septic tank systems and sewage treatment plants. This information would be important to Big Thicket National Preserve personnel since so much private lands exists between and upstream of the preserve's management units. This information would need to be

updated every five years or so and most likely should be tied into the Geographic Information System (GIS).

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APPENDIX A

Big Thicket National Preserve

Water Quality Monitoring Data: November 1984 - November 1986

STATION NAME: BEECH CREEK SITE # 1 (BC-1)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/07/84 | 15 | 5.9 | 5.9 | 7 | 70 | 10 | 17 | 9 | <10 | 200 | 5 | 118 | <10 | 70 | 115 | | |
| 12/06/84 | 8 | 5.3 | 9.7 | 11 | 60 | | | | | | | | | | | | high |
| 01/10/85 | 11 | 5.9 | 8.8 | 7 | 66 | 4 | 18 | 12 | <5 | 125 | 3 | 102 | <10 | 100 | 10 | | mid |
| 02/19/85 | 14 | 5.9 | 8.9 | 32 | 60 | | | | | | | | | | | | mid |
| 03/19/85 | 15 | 5.8 | 7.8 | 11 | 55 | | | | | | | | | | | | low |
| 04/22/85 | 22 | 6.1 | 4.8 | 14 | 58 | 10 | 24 | 9 | <10 | 100 | 17 | 87 | | 50 | 140 | | low |
| 05/21/85 | 20 | 6.1 | 3.0 | 10 | 61 | | | | | | | | | | | | low |
| 06/18/85 | 25 | 6.0 | 0.9 | 17 | 82 | | | | | | | | | | | | pool |
| 07/29/85 | 26 | 6.0 | 2.2 | 6 | 59 | 10 | | 6 | 17 | 150 | 9 | 90 | | 10 | 330 | | low |
| 08/20/85 | 27 | | 1.4 | 7 | 63 | | | | | | | | | | | | pool |
| 09/26/85 | 21 | | 3.6 | 42 | 60 | | | | | | | | | | | | pool |
| 11/05/85 | 10 | | 8.6 | 8 | 68 | 4 | | 10 | <5 | 300 | 4 | 132 | | 80 | 100 | | mid |
| 12/03/85 | 7 | | 9.5 | 11 | 55 | | | | | | | | | | | | mid |
| 01/07/86 | 9 | 5.6 | 9.4 | 8 | 56 | 6 | | 10 | <5 | 120 | 6 | 83 | | 60 | 160 | | mid |
| 02/04/86 | 17 | 5.4 | 7.3 | 18 | 35 | | | | | | | | | | | | flood |
| 03/04/86 | 12 | 5.8 | 8.4 | 15 | 52 | | | | | | | | | | | | mid |
| 04/02/86 | 18 | 6.2 | 5.2 | 15 | 58 | 10 | | 11 | <5 | 180 | 15 | 82 | | 100 | 140 | | low |
| 05/13/86 | 26 | 5.3 | 6.0 | 12 | 81 | | | | | | | | | | | | mid |
| 06/11/86 | 26 | 5.3 | 6.5 | 12 | 39 | | | | | | | | | | | | high |
| 07/14/86 | 23 | 5.8 | 3.5 | 12 | 41 | 12 | | 8 | 15 | 120 | 10 | 66 | | | 260 | | low |
| 07/21/86 | | | | | | | | | | | | | | 20 | 90 | | |
| 08/07/86 | 26 | 5.9 | 3.3 | 7 | 50 | | | | | | | | | | | | low |
| 09/23/86 | 23 | 6.1 | 7.3 | 18 | 52 | | | | | | | | | | | | low |
| 10/28/86 | 15 | 6.9 | | 12 | 51 | 6 | | 9 | 24 | 135 | 4 | 94 | | 220 | 280 | | low |
| Mean | 18 | 5.7 | 6.0 | 14 | 58 | 8 | 20 | 9 | | 159 | 8 | 95 | | 58* | 123* | | |
| Std dev | 6.6 | | 2.8 | 8.3 | 11.3 | 3.0 | 3.8 | 1.7 | | 61.6 | 5.1 | 20.0 | | | | | |
| n | 23 | 19 | 22 | 23 | 23 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 2 | 9 | 10 | | |
| High | 27 | 6.9 | 9.7 | 42 | 82 | 12 | 24 | 12 | 24 | 300 | 17 | 132 | | 220 | 330 | | |
| Median | | | | | | | | | <10 | | | | <10 | | | | |
| Low | 7 | 5.3 | 0.9 | 6 | 35 | 4 | 17 | 6 | <5 | 100 | 3 | 66 | | 10 | 10 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: BEECH CREEK SITE # 5 (BC-5)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/07/84 | 14 | 6.1 | 7.8 | 8 | 51 | 8 | 13 | 8 | <10 | 150 | 2 | 90 | <10 | 240 | 245 | | |
| 12/06/84 | 8 | 5.6 | 9.7 | 13 | 65 | | | | | | | | | | | | high |
| 01/10/85 | 11 | 6.1 | 9.6 | 7 | 53 | 6 | 32 | 10 | <5 | 75 | 2 | 85 | <10 | 120 | 60 | | mid |
| 02/19/85 | 13 | 5.9 | 9.9 | 9 | 51 | | | | | | | | | | | | mid |
| 03/19/85 | 15 | 6.1 | 9.1 | 11 | 49 | | | | | | | | | | | | mid |
| 04/22/85 | 22 | 6.3 | 6.5 | 15 | 45 | 8 | 12 | 7 | <10 | 140 | 12 | 75 | | 70 | 170 | | low |
| 05/21/85 | 20 | 6.3 | 6.8 | 21 | 45 | | | | | | | | | | | | mid |
| 06/18/85 | 25 | 6.4 | 2.4 | 17 | 54 | | | | | | | | | | | | low |
| 07/29/85 | 28 | 6.2 | 4.3 | 9 | 52 | 14 | | 8 | <5 | 100 | 3 | 81 | | 120 | 530 | | low |
| 08/20/85 | 27 | | 1.1 | 6 | 63 | | | | | | | | | | | | low |
| 09/26/85 | 22 | 5.1 | 1.9 | 4 | 58 | | | | | | | | | | | | pool |
| 11/05/85 | 10 | | 8.6 | 8 | 55 | 5 | | 9 | <5 | 175 | 5 | 102 | | 460 | 60 | | high |
| 12/03/85 | 7 | | 9.2 | 15 | 43 | | | | | | | | | | | | mid |
| 01/07/86 | 8 | 5.9 | 9.8 | 7 | 42 | 6 | | 8 | <5 | 80 | 4 | 63 | | 230 | 60 | | mid |
| 02/04/86 | 18 | 5.6 | 7.4 | 16 | 32 | | | | | | | | | | | | flood |
| 03/04/86 | 12 | 6.0 | 8.8 | 12 | 39 | | | | | | | | | | | | mid |
| 04/02/86 | 19 | 6.3 | 7.1 | 14 | 46 | 10 | | 10 | <5 | 120 | 8 | 71 | | 100 | 380 | | low |
| 05/13/86 | 26 | 5.8 | 6.7 | 14 | 41 | | | | | | | | | | | | mid |
| 06/11/86 | 26 | 5.1 | 7.0 | 9 | 25 | | | | | | | | | | | | flood |
| 07/14/86 | 25 | 5.8 | 5.9 | 9 | 30 | 6 | | 8 | 20 | 120 | 13 | 66 | | | 380 | | mid |
| 07/21/86 | | | | | | | | | | | | | | 110 | 310 | | |
| 08/07/86 | 24 | 5.9 | 5.3 | 7 | 30 | | | | | | | | | | | | low |
| 09/23/86 | 24 | 5.8 | 7.8 | 17 | 51 | | | | | | | | | | | | mid |
| 10/28/86 | 15 | 7.0 | | 11 | 46 | 6 | | 9 | 16 | 120 | 2 | 84 | | 400 | 340 | | low |
| Mean | 18 | 5.8 | 6.9 | 11 | 46 | 8 | 19 | 9 | | 120 | 6 | 80 | | 169* | 193* | | |
| Std dev | 6.9 | | 2.6 | 4.3 | 10.3 | 2.8 | 11.3 | 1.0 | | 32.3 | 4.3 | 12.3 | | | | | |
| n | 23 | 20 | 22 | 23 | 23 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 2 | 9 | 10 | | |
| High | 28 | 7.0 | 9.9 | 21 | 65 | 14 | 32 | 10 | 20 | 175 | 13 | 102 | | 460 | 530 | | |
| Median | | | | | | | | | <10 | | | | <10 | | | | |
| Low | 7 | 5.1 | 1.1 | 4 | 25 | 5 | 12 | 7 | <5 | 75 | 2 | 63 | | 70 | 60 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: BIG SANDY CREEK SITE # 1 (BS-1)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/07/84 | 16 | 7.1 | 8.5 | 13 | 93 | 26 | 32 | 11 | <10 | 65 | 9 | 96 | <10 | 260 | 270 | | |
| 12/06/84 | 9 | 6.8 | 10.5 | 30 | 89 | | | | | | | | | | | | mid |
| 01/10/85 | 12 | 6.7 | 9.9 | 12 | 87 | 22 | 32 | 14 | <5 | 40 | 5 | 103 | 31 | 210 | 80 | | mid |
| 02/20/85 | 15 | 6.9 | 9.4 | 12 | 98 | | | | | | | | | | | | mid |
| 03/18/85 | 18 | 6.9 | 9.0 | 13 | 92 | | | | | | | | | | | | mid |
| 04/22/85 | 21 | 7.1 | 7.6 | 14 | 98 | 26 | 30 | 12 | <10 | 55 | 8 | 92 | | 100 | 280 | | low |
| 05/22/85 | 23 | 7.1 | 8.0 | 16 | 104 | | | | | | | | | | | | low |
| 06/17/85 | 27 | 6.9 | 8.7 | 12 | 79 | | | | | | | | | | | | low |
| 07/30/85 | 26 | | 8.4 | 13 | 83 | 20 | | 14 | <5 | 60 | 7 | 84 | 10 | 240 | 580 | | low |
| 08/19/85 | 29 | | 8.6 | 7 | 72 | | | | | | | | | | | | low |
| 09/25/85 | 24 | 5.2 | 8.2 | 7 | 54 | | | | | | | | | | | | low |
| 11/05/85 | 13 | 7.0 | | 17 | 90 | 20 | | 12 | <5 | 70 | 12 | 109 | | 200 | 350 | | mid |
| 12/03/85 | 9 | | 10.2 | 30 | 79 | | | | | | | | | | | | mid |
| 01/07/86 | 9 | 5.9 | 10.3 | 8 | 83 | 18 | | 14 | <5 | 30 | 6 | 78 | | 110 | 140 | | mid |
| 02/03/86 | 18 | 6.6 | 8.3 | 8 | 80 | | | | | | | | | | | | low |
| 03/04/86 | 14 | 6.3 | 9.5 | 20 | 82 | | | | | | | | | | | | mid |
| 04/02/86 | 19 | 6.5 | 8.4 | 10 | 90 | 24 | | 14 | 8 | 50 | 6 | 82 | | 130 | 140 | | low |
| 05/14/86 | 24 | 6.3 | 7.2 | 27 | 81 | | | | | | | | | | | | low |
| 06/12/86 | 23 | 6.2 | 5.8 | 64 | 51 | | | | | | | | | | | | flood |
| 07/15/86 | 25 | 6.5 | 6.7 | 12 | 90 | 28 | | 12 | <10 | 60 | 12 | 83 | | 470 | 640 | | low |
| 08/08/86 | 24 | 6.4 | 6.6 | 10 | 82 | | | | | | | | | | | | low |
| 09/24/86 | 17 | 6.3 | 7.0 | 18 | 82 | | | | | | | | | | | | low |
| 10/29/86 | 17 | 6.8 | | 14 | 69 | 19 | | 13 | 6 | 90 | 7 | 82 | | 250 | 420 | | mid |
| 11/27/86 | 14 | 6.8 | | 45 | 64 | | | | | | | | | | | | high |
| | | | | | | | | | | | | | | | | | |
| Mean | 19 | 6.2 | 8.4 | 18 | 82 | 23 | 31 | 13 | | 58 | 8 | 90 | 14 | 197* | 265* | | |
| Std dev | 6.0 | | 1.3 | 13.3 | 12.9 | 3.6 | 1.2 | 1.2 | | 17.3 | 2.5 | 10.8 | | | | | |
| n | 24 | 21 | 21 | 24 | 24 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 3 | 9 | 9 | | |
| | | | | | | | | | | | | | | | | | |
| High | 29 | 7.1 | 10.5 | 64 | 104 | 28 | 32 | 14 | <10 | 90 | 12 | 109 | 31 | 470 | 640 | | |
| Median | | | | | | | | | | | | | 10 | | | | |
| Low | 9 | 5.2 | 5.8 | 7 | 51 | 18 | 30 | 11 | <5 | 30 | 5 | 78 | 0 | 100 | 80 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: BIG SANDY CREEK SITE # 2 (BS-2)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/07/84 | 17 | 6.9 | 8.7 | 14 | 90 | 28 | 32 | 10 | <10 | 65 | 13 | 100 | <10 | 200 | 1200 | |
| 12/06/84 | 9 | 6.8 | 10.7 | 49 | 86 | | | | | | | | | | | |
| 01/10/85 | 12 | 6.8 | 9.4 | 13 | 98 | 22 | 35 | 14 | 5 | 40 | 9 | 100 | <10 | 370 | 100 | |
| 02/20/85 | 17 | 7.0 | 9.3 | 14 | 99 | | | | | | | | | | | |
| 03/18/85 | 18 | 7.1 | 8.8 | 12 | 102 | | | | | | | | | | | |
| 04/22/85 | 22 | 7.1 | 9.0 | 13 | 96 | 28 | 30 | 13 | <10 | 45 | 11 | 85 | | 110 | 255 | |
| 05/22/85 | 24 | 7.0 | 7.7 | 15 | 95 | | | | | | | | | | | |
| 06/17/85 | 27 | 6.8 | 8.1 | 12 | 85 | | | | | | | | | | | |
| 07/30/85 | 26 | 6.6 | 9.0 | 14 | 83 | 22 | | 12 | <5 | 50 | 10 | 89 | | 10 | 390 | |
| 08/19/85 | 28 | | 7.6 | 11 | 76 | | | | | | | | | | | |
| 09/25/85 | 22 | 6.1 | 8.2 | 10 | 69 | | | | | | | | | | | |
| 11/05/85 | 12 | 6.9 | 10.1 | 20 | 61 | 20 | | 12 | <5 | 70 | 17 | 110 | | 520 | 220 | |
| 12/03/85 | 10 | | 10.1 | 36 | 65 | | | | | | | | | | | |
| 01/07/86 | 8 | 5.8 | 10.3 | 9 | 84 | 22 | | 12 | 8 | 30 | 7 | 81 | | 100 | 120 | |
| 02/03/86 | 18 | 6.7 | 9.8 | 9 | 80 | | | | | | | | | | | |
| 03/04/86 | 14 | 6.5 | 9.3 | 28 | 88 | | | | | | | | | | | |
| 04/02/86 | 18 | 6.8 | 8.5 | 10 | 92 | 26 | | 14 | 8 | 35 | 5 | 89 | | 100 | 160 | |
| 05/14/86 | 23 | 6.5 | 7.6 | 28 | 80 | | | | | | | | | | | |
| 06/12/86 | 23 | 6.1 | 5.8 | 65 | 53 | | | | | | | | | | | |
| 07/15/86 | 26 | 6.5 | 8.1 | 13 | 95 | 30 | | 13 | <10 | 50 | 14 | 90 | | 240 | 610 | |
| 08/08/86 | 24 | 6.4 | 7.6 | 10 | 77 | | | | | | | | | | | |
| 09/24/86 | 24 | 6.4 | 7.2 | 23 | 92 | | | | | | | | | | | |
| 10/29/86 | 16 | 6.9 | | 13 | 86 | 24 | | 13 | 6 | 45 | 8 | 90 | | 40 | 200 | |
| 11/27/86 | 13 | 6.3 | | 27 | 50 | | | | | | | | | | | |
| Mean | 19 | 6.5 | 8.7 | 19 | 83 | 25 | 32 | 13 | | 48 | 10 | 93 | | 117* | 264* | |
| Std dev | 6.1 | | 1.2 | 13.8 | 14.2 | 3.5 | 2.5 | 1.2 | | 13.0 | 3.7 | 9.0 | | | | |
| n | 24 | 22 | 22 | 24 | 24 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 2 | 9 | 9 | |
| High | 28 | 7.1 | 10.7 | 65 | 102 | 30 | 35 | 14 | | 70 | 17 | 110 | | 520 | 1200 | |
| Median | | | | | | | 32 | | <5 | | | | | | | |
| Low | 8 | 5.8 | 5.8 | 9 | 50 | 20 | 30 | 10 | | 30 | 5 | 81 | | 10 | 100 | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: BIG SANDY CREEK SITE # 3 (BS-3)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/07/84 | 22 | 6.8 | 9.0 | 14 | 80 | 26 | 30 | 14 | <10 | 70 | 14 | 94 | <10 | 180 | 285 | | |
| 12/06/84 | 9 | 6.9 | 10.3 | 37 | 94 | | | | | | | | | | | | high |
| 01/10/85 | 11 | 6.8 | 9.9 | 13 | 90 | 22 | 30 | 13 | <5 | 30 | 6 | 97 | <10 | 230 | 160 | | mid |
| 02/20/85 | 15 | 7.0 | 9.4 | 13 | 88 | | | | | | | | | | | | mid |
| 03/18/85 | 18 | 7.0 | 7.2 | 13 | 95 | | | | | | | | | | | | mid |
| 04/22/85 | 22 | 6.8 | 7.7 | 12 | 85 | 24 | 26 | 11 | <10 | 45 | 11 | 78 | | 60 | 320 | | mid |
| 05/22/85 | 24 | 7.1 | 9.7 | 14 | 92 | | | | | | | | | | | | mid |
| 06/17/85 | 26 | 7.0 | 8.8 | 14 | 71 | | | | | | | | | | | | low |
| 07/30/85 | 26 | 6.6 | | 12 | 98 | 16 | | 21 | <5 | 45 | 8 | 99 | | 140 | 175 | | low |
| 08/19/85 | 28 | | 7.3 | 11 | 71 | | | | | | | | | | | | low |
| 09/25/85 | 24 | 6.1 | 7.6 | 11 | 62 | | | | | | | | | | | | low |
| 11/05/85 | 14 | 6.9 | 9.4 | 21 | 84 | 19 | | 12 | <5 | 80 | 16 | 110 | | 130 | 240 | | mid |
| 12/03/85 | 10 | | 9.9 | 40 | 69 | | | | | | | | | | | | mid |
| 01/07/86 | 9 | 5.8 | 10.3 | 8 | 76 | 22 | | 12 | 8 | 35 | 6 | 77 | | 140 | 140 | | mid |
| 02/03/86 | 18 | 6.8 | 8.8 | 8 | 80 | | | | | | | | | | | | low |
| 03/04/86 | 11 | 6.5 | 9.2 | 28 | 86 | | | | | | | | | | | | mid |
| 04/02/86 | 19 | 6.8 | 8.1 | 10 | 85 | 24 | | 13 | 8 | 40 | 4 | 81 | | 100 | 80 | | low |
| 05/14/86 | 24 | 6.3 | 7.2 | 31 | 71 | | | | | | | | | | | | mid |
| 06/12/86 | 24 | 6.2 | 7.5 | 55 | 53 | | | | | | | | | | | | flood |
| 07/15/86 | 25 | 6.7 | 6.7 | 14 | 85 | 28 | | 11 | <10 | 55 | 12 | 82 | | 110 | 170 | | low |
| 08/08/86 | 26 | 6.6 | 7.9 | 9 | 59 | | | | | | | | | | | | low |
| 09/24/86 | 25 | 6.5 | 7.1 | 32 | 71 | | | | | | | | | | | | low |
| 10/29/86 | 17 | 6.8 | | 17 | 70 | 22 | | 13 | 6 | 30 | 10 | 82 | | 90 | 250 | | low |
| 11/27/86 | 13 | 6.8 | | 50 | 50 | | | | | | | | | | | | flood |
| Mean | 19 | 6.5 | 8.5 | 20 | 78 | 23 | 29 | 13 | | 48 | 10 | 89 | | 123* | 188* | | |
| Std dev | 6.3 | | 1.2 | 13.6 | 13.2 | 3.6 | 2.3 | 3.0 | | 17.5 | 4.0 | 11.5 | | | | | |
| n | 24 | 22 | 21 | 24 | 24 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 2 | 9 | 9 | | |
| High | 28 | 7.1 | 10.3 | 55 | 98 | 28 | 30 | 21 | | 80 | 16 | 110 | | 230 | 320 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 9 | 5.8 | 6.7 | 8 | 50 | 16 | 26 | 11 | <5 | 30 | 4 | 77 | | 60 | 80 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: BIG SANDY CREEK SITE # 5 (BS-5)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/07/84 | 17 | 6.8 | 8.6 | 15 | 69 | 20 | 26 | 8 | <10 | 70 | 12 | 90 | <10 | 100 | 160 | | |
| 12/06/84 | 10 | 6.8 | 10.6 | 26 | 82 | | | | | | | | | | | | flood |
| 01/10/85 | 11 | 6.6 | 9.9 | 14 | 73 | 14 | 21 | 10 | <5 | 30 | 8 | 97 | <10 | 190 | 80 | | mid |
| 02/20/85 | 15 | 6.7 | 9.2 | 14 | 76 | | | | | | | | | | | | mid |
| 03/18/85 | 18 | 6.9 | 6.3 | 16 | 90 | | | | | | | | | | | | mid |
| 04/22/85 | 23 | 6.9 | 7.5 | 12 | 52 | 20 | 20 | 9 | <10 | 35 | 9 | 76 | | 110 | 145 | | mid |
| 05/22/85 | 22 | 6.9 | 9.3 | 15 | 67 | | | | | | | | | | | | mid |
| 06/17/85 | 27 | 6.9 | 8.4 | 15 | 62 | | | | | | | | | | | | low |
| 07/30/85 | 28 | 6.6 | 8.1 | 10 | 47 | 14 | | 10 | <5 | 70 | 6 | 65 | | 60 | 170 | | low |
| 08/19/85 | 28 | | 9.2 | 11 | 47 | | | | | | | | | | | | low |
| 09/25/85 | 23 | 7.0 | 7.7 | 9 | 52 | | | | | | | | | | | | mid |
| 11/05/85 | 14 | 6.9 | 9.0 | 18 | 75 | 15 | | 11 | <5 | 80 | 15 | 98 | | 110 | 120 | | mid |
| 12/03/85 | 11 | | 9.1 | 41 | 65 | | | | | | | | | | | | high |
| 01/07/86 | 9 | 6.1 | 10.4 | 8 | 62 | 16 | | 11 | 7 | 35 | 5 | 68 | | 70 | 70 | | mid |
| 02/03/86 | 18 | 6.9 | 9.0 | 9 | 63 | | | | | | | | | | | | low |
| 03/04/86 | 12 | 6.7 | 9.3 | 11 | 71 | | | | | | | | | | | | mid |
| 04/02/86 | 18 | 6.7 | 8.4 | 13 | 69 | 18 | | 12 | 6 | 50 | 11 | 67 | | 100 | 20 | | low |
| 05/14/86 | 26 | 6.2 | 7.5 | 32 | 58 | | | | | | | | | | | | low |
| 06/12/86 | 25 | 6.1 | 6.8 | 30 | 58 | | | | | | | | | | | | flood |
| 07/15/86 | 27 | 6.6 | 6.6 | 14 | 58 | 18 | | 9 | <10 | 70 | 15 | 74 | | 140 | 80 | | low |
| 08/08/86 | 26 | 5.9 | 3.1 | 17 | 54 | | | | | | | | | | | | low |
| 09/24/86 | 25 | 5.9 | | 20 | 50 | | | | | | | | | | | | mid |
| 10/29/86 | 19 | 6.9 | | 16 | 57 | 14 | | 13 | 5 | 50 | 6 | 76 | | 80 | 150 | | low |
| 11/27/86 | 14 | 6.1 | | 44 | 35 | | | | | | | | | | | | flood |
| Mean | 19 | 6.4 | 8.3 | 18 | 62 | 17 | 22 | 10 | | 54 | 10 | 79 | | 101* | 95* | | |
| Std dev | 6.4 | | 1.7 | 9.7 | 12.4 | 2.5 | 3.2 | 1.6 | | 18.6 | 3.8 | 12.8 | | | | | |
| n | 24 | 22 | 21 | 24 | 24 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 2 | 9 | 9 | | |
| High | 28 | 7.0 | 10.6 | 44 | 90 | 20 | 26 | 13 | | 80 | 15 | 98 | | 190 | 170 | | |
| Median | | | | | | | | | <10 | | | | <10 | | | | |
| Low | 9 | 5.9 | 3.1 | 8 | 35 | 14 | 20 | 8 | | 30 | 5 | 65 | | 60 | 20 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: BIG SANDY CREEK WOODLAND SITE (BS-W)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07/30/85 | 27 | 6.0 | 8.0 | 12 | 73 | 22 | | 11 | <5 | 45 | 8 | 84 | <10 | 200 | 140 | | low |
| 09/25/85 | 24 | 6.8 | 7.6 | 9 | 70 | | | | | | | | | | | | low |
| 11/05/85 | 12 | 6.9 | 9.5 | 21 | 62 | 19 | | 11 | <5 | 100 | 14 | 114 | | 190 | 130 | | mid |
| 12/03/85 | 9 | | 10.7 | 37 | 62 | | | | | | | | | | | | mid |
| 01/07/86 | 9 | 6.1 | 9.9 | 9 | 96 | 26 | | 14 | 8 | 25 | 5 | 88 | | 80 | 40 | | mid |
| 04/02/86 | 19 | 6.9 | 8.6 | 10 | 104 | 32 | | 15 | 8 | 35 | 6 | 90 | <10 | 70 | 110 | | low |
| 07/15/86 | 27 | 6.6 | 7.7 | 12 | 96 | 30 | | 13 | <10 | 35 | 9 | 88 | | 80 | 230 | | low |
| 10/29/86 | 22 | 6.9 | | 6 | 40 | 8 | | 8 | 6 | 30 | 10 | 48 | | 10 | 20 | | mid |
| Mean | 19 | 6.4 | 8.9 | 14 | 75 | 23 | | 12 | | 45 | 9 | 85 | | 74* | 85* | | |
| Std dev | 7.7 | | 1.2 | 10.1 | 21.8 | 8.7 | | 2.5 | | 27.7 | 3.2 | 21.2 | | | | | |
| n | 8 | 7 | 7 | 8 | 8 | 6 | | 6 | 6 | 6 | 6 | 6 | 2 | 6 | 6 | | |
| High | 27 | 6.9 | 10.7 | 37 | 104 | 32 | | 15 | | 100 | 14 | 114 | | 200 | 230 | | |
| Median | | | | | | | | | | | | | <10 | | | | |
| Low | 9 | 6.0 | 7.6 | 6 | 40 | 8 | | 8 | <5 | 25 | 5 | 48 | | 10 | 20 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: JACK GORE BAYGALL SITE # 1 (JG-1) (BLACK CREEK)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/08/84 | 17 | 5.7 | 4.6 | 16 | 61 | 6 | 23 | 8 | <10 | 250 | 7 | 135 | <10 | 80 | 20 | | |
| 12/07/84 | 8 | 5.7 | 7.8 | 27 | 49 | | | | | | | | | | | | flood |
| 01/08/85 | 8 | 6.0 | 9.3 | 26 | 63 | 6 | 14 | 12 | <5 | 175 | 11 | 137 | 31 | 270 | 100 | | mid |
| 02/19/85 | 14 | 5.8 | 8.2 | 9 | 50 | | | | | | | | | | | | high |
| 03/19/85 | 18 | 6.0 | 5.8 | 32 | 70 | | | | | | | | | | | | mid |
| 04/22/85 | 22 | 6.3 | 5.7 | 16 | 127 | 16 | 26 | 20 | 15 | 48 | 7 | 121 | 24 | 5 | 90 | | low |
| 05/21/85 | 25 | 6.5 | 7.5 | 27 | 66 | | | | | | | | | | | | low |
| 06/18/85 | 27 | 6.4 | 6.3 | 11 | 67 | | | | | | | | | | | | low |
| 07/29/85 | 28 | 6.0 | 6.2 | 4 | 66 | 8 | | 10 | 15 | 35 | 5 | 75 | | 240 | 1520 | | low |
| 08/20/85 | 28 | | 3.7 | 4 | 81 | | | | | | | | | | | | low |
| 09/26/85 | 22 | | 4.7 | 4 | 69 | | | | | | | | | | | | low |
| 11/04/85 | 15 | | 5.5 | 10 | 85 | 4 | | 10 | <5 | 240 | 8 | 120 | | 30 | 40 | | mid |
| 12/02/85 | 13 | | 4.3 | 18 | 64 | | | | | | | | | | | | high |
| 01/08/86 | 9 | 6.0 | 6.3 | 17 | 55 | 6 | | 12 | 6 | 140 | 5 | 105 | | 20 | 30 | | mid |
| 02/04/86 | 18 | 6.1 | 5.7 | 24 | 63 | | | | | | | | | | | | flood |
| 03/03/86 | 16 | 5.8 | 5.7 | 29 | 66 | | | | | | | | | | | | mid |
| 04/01/86 | 19 | 5.9 | 6.5 | 24 | 66 | 8 | | 14 | 8 | 140 | 14 | 116 | | 20 | 180 | | low |
| 05/16/86 | 24 | 5.8 | 2.9 | 21 | 63 | | | | | | | | | | | | mid |
| 06/09/86 | 26 | 5.9 | 5.5 | 56 | 25 | | | | | | | | | | | | flood |
| 07/16/86 | 26 | 6.1 | 5.5 | 15 | 127 | 19 | | 18 | 19 | 55 | 15 | 107 | | 40 | 40 | | high |
| 08/22/86 | 28 | 6.6 | 7.7 | 10 | 179 | | | | | | | | | | | | low |
| 09/22/86 | 29 | 6.4 | 5.5 | 2 | 94 | | | | | | | | | | | | low |
| 10/27/86 | 18 | 7.0 | | 11 | 81 | 4 | | 14 | 17 | 150 | 9 | 111 | | 70 | 20 | | low |
| 11/24/86 | 21 | 7.3 | | 77 | 54 | | | | | | | | | | | | flood |
| Mean | 20 | 6.0 | 6.0 | 20 | 75 | 9 | 21 | 13 | | 137 | 9 | 114 | | 46* | 71* | | |
| Std dev | 6.6 | | 1.5 | 16.9 | 31.3 | 5.3 | 6.2 | 3.9 | | 79.1 | 3.6 | 18.4 | | | | | |
| n | 24 | 20 | 22 | 24 | 24 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 3 | 9 | 9 | | |
| High | 29 | 7.3 | 9.3 | 77 | 179 | 19 | 26 | 20 | 19 | 250 | 15 | 137 | 31 | 270 | 1520 | | |
| Median | | | | | | | | | <10 | | | | | | | | |
| Low | 8 | 5.7 | 2.9 | 2 | 25 | 4 | 14 | 8 | <5 | 35 | 5 | 75 | <10 | 5 | 20 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: JACK GORE BAYGALL SITE # 2 (JG-2) (BLACK CREEK)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/08/84 | 18 | 5.9 | 5.2 | 16 | 68 | 8 | 17 | 9 | <10 | 250 | 8 | 139 | <10 | 70 | 120 | | |
| 12/07/84 | 7 | 5.9 | 8.9 | 25 | 47 | | | | | | | | | | | | flood |
| 01/08/85 | 8 | 5.9 | 8.0 | 27 | 56 | 6 | 16 | 12 | <5 | 200 | 14 | 139 | 24 | 400 | 115 | | mid |
| 02/19/85 | 12 | 6.3 | 8.8 | 36 | 104 | | | | | | | | | | | | high |
| 03/19/85 | | | | | | | | | | | | | | | | | |
| 04/22/85 | | | | | | | | | | | | | | | | | |
| 05/21/85 | 25 | 6.5 | 5.8 | 30 | 131 | | | | | | | | | | | | mid |
| 06/18/85 | 26 | 6.2 | 3.1 | 30 | 74 | | | | | | | | | | | | low |
| 07/29/85 | 27 | 6.0 | 3.5 | 16 | 76 | 10 | | 10 | 15 | 65 | 10 | 94 | | 50 | 5540 | | low |
| 08/20/85 | 26 | | 1.6 | 13 | 98 | | | | | | | | | | | | pool |
| 09/26/85 | 21 | 5.6 | 5.7 | 26 | 82 | | | | | | | | | | | | low |
| 11/04/85 | 15 | 5.1 | 6.0 | 13 | 86 | 5 | | 9 | <5 | 200 | 9 | 118 | | 60 | 120 | | mid |
| 12/02/85 | 11 | | 5.2 | 20 | 66 | | | | | | | | | | | | mid |
| 01/06/86 | 9 | 6.2 | 7.6 | 17 | 62 | 8 | | 11 | 12 | 160 | 12 | 102 | | 80 | 40 | | mid |
| 02/04/86 | | | | | | | | | | | | | | | | | |
| 03/03/86 | 15 | 6.0 | 8.5 | 24 | 116 | | | | | | | | | | | | mid |
| 04/01/86 | 19 | 6.0 | 6.0 | 26 | 66 | 8 | | 14 | <5 | 180 | 18 | 124 | <10 | 120 | 470 | | low |
| 05/16/86 | 26 | 5.9 | 3.5 | 27 | 81 | | | | | | | | | | | | mid |
| 06/09/86 | | | | | | | | | | | | | | | | | |
| 07/16/86 | | | | | | | | | | | | | | | | | |
| 08/22/86 | 30 | 6.3 | 4.2 | 4 | 172 | | | | | | | | | | | | low |
| 09/22/86 | | | | | | | | | | | | | | | | | |
| 10/27/86 | | | | | | | | | | | | | | | | | |
| Mean | 18 | 5.8 | 5.7 | 22 | 87 | 8 | 17 | 11 | | 176 | 12 | 119 | | 96* | 236* | | |
| Std dev | 7.7 | | 2.2 | 8.2 | 31.8 | 1.8 | 0.7 | 1.9 | | 62.0 | 3.7 | 18.7 | | | | | |
| n | 16 | 14 | 16 | 16 | 16 | 6 | 2 | 6 | 6 | 6 | 6 | 6 | 3 | 6 | 6 | | |
| High | 30 | 6.5 | 8.9 | 36 | 172 | 10 | 17 | 14 | 15 | 250 | 18 | 139 | 24 | 400 | 5540 | | |
| Median | | | | | | | | | <10 | | | | | | | | |
| Low | 7 | 5.1 | 1.6 | 4 | 47 | 5 | 16 | 9 | <5 | 65 | 8 | 94 | <10 | 50 | 40 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: LOWER NECHES SITE # 1 (LN-1)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/10/85 | 12 | 6.9 | 10.4 | 34 | 153 | 18 | 39 | 22 | 20 | 90 | 31 | 167 | <10 | 140 | 65 | | mid |
| 07/29/85 | 31 | 6.8 | 6.9 | 10 | 147 | 20 | | 21 | 26 | 25 | 38 | 116 | | 10 | 40 | | mid |
| 01/06/86 | 10 | 6.8 | 10.5 | 20 | 123 | 12 | | 22 | 24 | 35 | 27 | 121 | | 40 | 30 | | mid |
| 07/17/86 | 26 | 6.3 | 6.7 | 15 | 147 | 22 | | 20 | 19 | 40 | 20 | 113 | | 50 | 150 | | mid |
| Mean | 20 | 6.6 | 8.6 | 20 | 143 | 18 | | 21 | 22 | 48 | 29 | 129 | | 41* | 58* | | |
| Std dev | 10.3 | | 2.1 | 10.3 | 13.3 | 4.3 | | 1.0 | 3.3 | 29.0 | 7.5 | 25.4 | | | | | |
| n | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 | | |
| High | 31 | 6.9 | 10.5 | 34 | 153 | 22 | | 22 | 26 | 90 | 38 | 167 | | 140 | 150 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 10 | 6.3 | 6.7 | 10 | 123 | 12 | | 20 | 19 | 25 | 20 | 113 | | 10 | 30 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: LOWER NECHES SITE # 3 (LN-3)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/10/85 | 11 | 6.8 | 10.1 | 32 | 146 | 16 | 37 | 22 | 18 | 90 | 29 | 161 | | 140 | 85 | | mid |
| 07/29/85 | 30 | 6.7 | 7.3 | 9 | 145 | 22 | | 21 | 24 | 25 | 26 | 119 | | 60 | 50 | | mid |
| 01/06/86 | 10 | 7.1 | 10.2 | 20 | 122 | 12 | | 20 | 24 | 50 | 25 | 117 | | 50 | 30 | | mid |
| 07/17/86 | 26 | 6.3 | 5.9 | 18 | 139 | 20 | | 19 | 19 | 40 | 20 | 113 | | 80 | 140 | | mid |
| Mean | 19 | 6.6 | 8.4 | 20 | 138 | 18 | | 21 | 21 | 51 | 25 | 128 | | 76* | 65* | | |
| Std dev | 10.2 | | 2.1 | 9.5 | 11.1 | 4.4 | | 1.3 | 3.2 | 27.8 | 3.7 | 22.5 | | | | | |
| n | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | | 4 | 4 | | |
| High | 30 | 7.1 | 10.2 | 32 | 146 | 22 | | 22 | 24 | 90 | 29 | 161 | | 140 | 140 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 10 | 6.3 | 5.9 | 9 | 122 | 12 | | 19 | 18 | 25 | 20 | 113 | | 50 | 30 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: LOWER NECHES SITE # 4 (LN-4)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/10/85 | 11 | 6.8 | 10.1 | 32 | 139 | 16 | 35 | 22 | 18 | 90 | 28 | 156 | <10 | 150 | 110 | | mid |
| 07/29/85 | 30 | 6.7 | 6.9 | 11 | 140 | 20 | | 21 | 26 | 25 | 19 | 114 | | 100 | 120 | | mid |
| 01/06/86 | 10 | 7.1 | 10.0 | 21 | 115 | 12 | | 20 | 22 | 60 | 30 | 117 | | 50 | 10 | | mid |
| 07/17/86 | 28 | 6.3 | 5.8 | 16 | 122 | 20 | | 19 | 19 | 35 | 20 | 106 | | 20 | 400 | | mid |
| Mean | 20 | 6.6 | 8.2 | 20 | 129 | 17 | | 21 | 21 | 53 | 24 | 123 | | 62* | 85* | | |
| Std dev | 10.7 | | 2.2 | 9.0 | 12.5 | 3.8 | | 1.3 | 3.6 | 29.0 | 5.6 | 22.3 | | | | | |
| n | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 | | |
| High | 30 | 7.1 | 10.1 | 32 | 140 | 20 | | 22 | 26 | 90 | 30 | 156 | | 150 | 400 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 10 | 6.3 | 5.8 | 11 | 115 | 12 | | 19 | 18 | 25 | 19 | 106 | | 20 | 10 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: LITTLE PINE ISLAND BAYOU SITE # 1 (LPI-1)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/09/84 | 21 | 5.8 | 4.3 | 12 | 120 | | | | | | | | | | | | |
| 12/05/84 | 9 | 6.2 | 8.7 | 68 | 76 | | | | | | | | | | | | flood |
| 01/07/85 | 9 | 5.6 | 12.3 | 24 | 87 | 4 | 18 | 18 | <5 | 275 | 11 | 168 | <10 | 170 | 70 | | mid |
| 02/20/85 | 13 | 5.8 | 7.8 | 29 | 70 | | | | | | | | | | | | high |
| 03/18/85 | 12 | 6.4 | 6.3 | 31 | 73 | | | | | | | | | | | | mid |
| 04/24/85 | 23 | 6.3 | 1.1 | 27 | 4467 | | | | | | | | | | | | low |
| 05/22/85 | 23 | 6.2 | 1.5 | 23 | 131 | | | | | | | | | | | | low |
| 06/17/85 | 27 | 6.5 | 1.4 | 14 | 106 | | | | | | | | | | | | low |
| 07/31/85 | 27 | 5.8 | 1.3 | 16 | 16241 | 14 | | 1400 | 17 | 50 | 12 | 2725 | <10 | 900 | 580 | | low |
| 08/19/85 | 29 | | 6.4 | 6 | 5077 | | | | | | | | | | | | low |
| 09/25/85 | 24 | 6.4 | 3.0 | 6 | 4182 | | | | | | | | | | | | low |
| 11/06/85 | 10 | 5.8 | 7.4 | 14 | 108 | | | | | | | | | | | | high |
| 12/04/85 | 11 | | 7.3 | 26 | 66 | | | | | | | | | | | | flood |
| 01/09/86 | 6 | 5.9 | 7.4 | 17 | 143 | 6 | | 24 | <5 | 200 | 2 | 138 | | 30 | 40 | | low |
| 02/03/86 | 18 | 6.1 | 1.9 | 15 | 2300 | | | | | | | | | | | | low |
| 03/05/86 | 15 | 5.6 | 4.8 | 31 | 200 | | | | | | | | | | | | mid |
| 04/04/86 | 18 | 6.1 | 1.6 | 13 | 224 | | | | | | | | | | | | low |
| 05/16/86 | 24 | 5.8 | 4.5 | 37 | 153 | | | | | | | | | | | | low |
| 06/09/86 | 27 | 5.4 | 6.5 | 18 | 26 | | | | | | | | | | | | flood |
| 07/16/86 | 28 | 5.7 | 0.6 | 22 | 76 | 8 | | 13 | 30 | 240 | 14 | | | 20 | 230 | | low |
| 08/22/86 | 27 | 6.3 | 2.7 | 6 | 202 | | | | | | | | | | | | low |
| 09/22/86 | 28 | 6.2 | 2.5 | 13 | 299 | | | | | | | | | | | | mid |
| 10/27/86 | 19 | 7.7 | | 26 | 56 | 6 | | 14 | 24 | 175 | 23 | 125 | | 550 | 710 | | mid |
| 11/24/86 | 20 | 6.8 | | 28 | 133 | | | | | | | | | | | | flood |
| Mean | 20 | 5.9 | 4.6 | 22 | 1442 | 8 | | 294 | | 188 | 12 | 789 | | 138* | 193* | | |
| Std dev | 7.3 | | 3.1 | 13.1 | 3506 | 3.8 | | 618.4 | | 86.1 | 7.5 | 1290.8 | | | | | |
| n | 24 | 22 | 22 | 24 | 24 | 5 | 1 | 5 | 5 | 5 | 5 | 4 | 2 | 5 | 5 | | |
| High | 29 | 7.7 | 12.3 | 68 | 16241 | 14 | | 1400 | 30 | 275 | 23 | 2725 | | 900 | 710 | | |
| Median | | | | | | | | | 17 | | | | <10 | | | | |
| Low | 6 | 5.4 | 0.6 | 6 | 26 | 4 | | 13 | <5 | 50 | 2 | 125 | | 20 | 40 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: LITTLE PINE ISLAND BAYOU SITE # 2 (LPI-2)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/09/84 | 22 | 6.3 | 4.7 | 12 | 188 | | | | | | | | | | | | |
| 12/05/84 | 10 | 6.3 | 7.4 | 37 | 232 | | | | | | | | | | | | flood |
| 01/07/85 | 11 | 5.8 | 11.2 | 21 | 93 | 4 | 21 | 19 | <5 | 250 | 9 | 172 | <10 | 200 | 95 | | mid |
| 02/20/85 | 14 | 5.9 | 7.3 | 28 | 111 | | | | | | | | | | | | high |
| 03/18/85 | 14 | 6.1 | 5.7 | 29 | 93 | | | | | | | | | | | | mid |
| 04/24/85 | 23 | 6.3 | 3.8 | 18 | 151 | | | | | | | | | | | | low |
| 05/22/85 | 22 | 6.3 | 5.2 | 15 | 159 | | | | | | | | | | | | low |
| 06/17/85 | 28 | 6.5 | 2.8 | 33 | 170 | | | | | | | | | | | | low |
| 07/31/85 | 27 | 5.6 | 4.4 | 10 | 163 | 20 | | 40 | 13 | 60 | 16 | 142 | <10 | 70 | 270 | | low |
| 08/19/85 | 29 | | 4.0 | 6 | 1025 | | | | | | | | | | | | low |
| 09/25/85 | 22 | 6.7 | 3.4 | 5 | 1062 | | | | | | | | | | | | low |
| 11/06/85 | 13 | 6.1 | 6.9 | 13 | 140 | | | | | | | | | | | | high |
| 12/04/85 | 14 | | 8.8 | 23 | 75 | | | | | | | | | | | | mid |
| 01/09/86 | 6 | 6.0 | 7.3 | 17 | 117 | 8 | | 32 | <5 | 200 | 5 | 158 | | 120 | 110 | | mid |
| 02/03/86 | 16 | 6.5 | 4.0 | 11 | 199 | | | | | | | | | | | | mid |
| 03/05/86 | 15 | 6.1 | 7.1 | 32 | 181 | | | | | | | | | | | | mid |
| 04/04/86 | 14 | 6.4 | 2.6 | 12 | 274 | | | | | | | | | | | | low |
| 05/16/86 | 24 | 6.2 | 5.2 | 13 | 276 | | | | | | | | | | | | mid |
| 06/09/86 | 25 | 5.6 | 5.5 | 19 | 25 | | | | | | | | | | | | flood |
| 07/16/86 | 29 | 6.1 | 2.3 | 16 | 131 | 14 | | 31 | 30 | 220 | 20 | 153 | | 200 | 220 | | low |
| 08/22/86 | 28 | 6.5 | 5.1 | 11 | 189 | | | | | | | | | | | | low |
| 09/22/86 | 28 | 6.3 | 4.6 | 8 | 159 | | | | | | | | | | | | mid |
| 10/26/86 | 20 | 7.6 | | 27 | 61 | 4 | | 14 | 25 | 175 | 12 | 116 | | 410 | 2030 | | mid |
| 11/24/86 | 21 | 7.1 | | 47 | 39 | | | | | | | | | | | | flood |
| Mean | 20 | 6.1 | 5.4 | 19 | 221 | 10 | | 27 | | 181 | 12 | 148 | | 169* | 263* | | |
| Std dev | 6.8 | | 2.2 | 10.7 | 261.4 | 6.9 | | 10.5 | | 73.0 | 5.9 | 21.0 | | | | | |
| n | 24 | 22 | 22 | 24 | 24 | 5 | 1 | 5 | 5 | 5 | 5 | 5 | 2 | 5 | 5 | | |
| High | 29 | 7.6 | 11.2 | 47 | 1062 | 20 | | 40 | 30 | 250 | 20 | 172 | | 410 | 2030 | | |
| Median | | | | | | | | | 13 | | | | <10 | | | | |
| Low | 6 | 5.6 | 2.3 | 5 | 25 | 4 | | 14 | | 60 | 5 | 116 | | 70 | 95 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: LITTLE PINE ISLAND BAYOU SITE # 3 (LPI-3)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/09/84 | 20 | 6.5 | 6.4 | 18 | 154 | | | | | | | | | | | | |
| 12/05/84 | 10 | 6.4 | 9.1 | 42 | 139 | | | | | | | | | | | | flood |
| 01/07/85 | 9 | 6.4 | 11.2 | 27 | 113 | 6 | 23 | 27 | <5 | 225 | 18 | 187 | <10 | 350 | 165 | | mid |
| 02/20/85 | 13 | 6.0 | 8.3 | 33 | 102 | | | | | | | | | | | | flood |
| 03/18/85 | 12 | 6.5 | 7.6 | 31 | 133 | | | | | | | | | | | | mid |
| 04/24/85 | 23 | 6.5 | 3.7 | 38 | 315 | | | | | | | | | | | | low |
| 05/22/85 | 24 | 6.2 | 5.3 | 116 | 314 | | | | | | | | | | | | low |
| 06/17/85 | 26 | 6.8 | 3.6 | 15 | 279 | | | | | | | | | | | | low |
| 07/31/85 | 26 | 6.0 | 4.5 | 15 | 294 | 42 | | 74 | 10 | 45 | 12 | 222 | | 200 | 480 | | low |
| 08/19/85 | 28 | | 5.0 | 12 | 428 | | | | | | | | | | | | low |
| 09/25/85 | 22 | 6.5 | 5.2 | 3 | 380 | | | | | | | | | | | | low |
| 11/06/85 | 12 | 6.3 | 8.7 | 17 | 121 | | | | | | | | | | | | high |
| 12/04/85 | 10 | | 9.3 | 25 | 88 | | | | | | | | | | | | flood |
| 01/09/86 | 7 | 6.2 | 8.9 | 19 | 172 | 12 | | 52 | <5 | 120 | 6 | 197 | | 20 | 20 | | low |
| 02/03/86 | 20 | 6.2 | 5.4 | 15 | 279 | | | | | | | | | | | | low |
| 03/05/86 | 15 | 5.8 | 8.8 | 39 | 68 | | | | | | | | | | | | flood |
| 04/04/86 | 20 | 6.6 | 4.4 | 21 | 434 | | | | | | | | | | | | low |
| 05/16/86 | 24 | 6.2 | 5.3 | 33 | 227 | | | | | | | | | | | | low |
| 06/09/86 | 26 | 5.6 | 4.8 | 14 | 25 | | | | | | | | | | | | flood |
| 07/16/86 | 29 | 6.1 | 3.9 | 17 | 159 | 18 | | 42 | 32 | 210 | 16 | 179 | | 60 | 160 | | low |
| 08/22/86 | 25 | 6.4 | 3.9 | 8 | 210 | | | | | | | | | | | | low |
| 09/22/86 | 26 | 6.1 | 6.5 | 29 | 97 | | | | | | | | | | | | mid |
| 10/27/86 | 22 | 6.1 | | 20 | 138 | 7 | | 46 | 26 | 150 | 10 | 184 | | 280 | 1090 | | mid |
| 11/24/86 | 21 | 6.3 | | 90 | 50 | | | | | | | | | | | | flood |
| Mean | 20 | 6.2 | 6.4 | 29 | 197 | 17 | | 48 | | 150 | 12 | 194 | | 119* | 194* | | |
| Std dev | 6.8 | | 2.2 | 25.2 | 118.1 | 14.8 | | 17.1 | | 72.7 | 4.8 | 17.1 | | | | | |
| n | 24 | 22 | 22 | 24 | 24 | 5 | 1 | 5 | 5 | 5 | 5 | 5 | 1 | 5 | 5 | | |
| High | 29 | 6.8 | 11.2 | 116 | 434 | 42 | | 74 | 32 | 225 | 18 | 222 | | 350 | 1090 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 7 | 5.6 | 3.6 | 3 | 25 | 6 | | 27 | <5 | 45 | 6 | 179 | | 20 | 20 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: LITTLE PINE ISLAND BAYOU SITE # 5 (LPI-5)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/09/84 | 20 | 6.6 | 6.4 | 39 | 138 | | | | | | | | | | | | |
| 12/05/84 | 10 | 6.8 | 8.9 | 89 | 161 | | | | | | | | | | | | high |
| 01/07/85 | 9 | 6.5 | | 60 | 153 | 20 | 39 | 36 | 6 | 175 | 25 | 227 | <10 | 940 | 355 | | mid |
| 02/20/85 | 13 | 6.2 | 7.6 | 61 | 76 | | | | | | | | | | | | flood |
| 03/18/85 | 17 | 6.5 | 6.9 | 71 | 129 | | | | | | | | | | | | mid |
| 04/24/85 | 24 | 6.9 | 4.7 | 64 | 273 | | | | | | | | | | | | low |
| 05/22/85 | 27 | 6.6 | 4.2 | 120 | 279 | | | | | | | | | | | | low |
| 06/17/85 | 28 | 7.0 | 4.0 | 34 | 219 | | | | | | | | | | | | low |
| 07/31/85 | 28 | 6.3 | 4.9 | 39 | 217 | 46 | | 38 | 20 | 55 | 30 | 180 | | 50 | 80 | | low |
| 08/19/85 | 29 | | 6.2 | 24 | 309 | | | | | | | | | | | | low |
| 09/25/85 | 25 | 6.8 | 4.3 | 36 | 263 | | | | | | | | | | | | low |
| 11/06/85 | 14 | 6.6 | 7.1 | 33 | 93 | | | | | | | | | | | | flood |
| 12/04/85 | 12 | | 7.3 | 55 | 81 | | | | | | | | | | | | flood |
| 01/09/86 | 8 | 6.2 | 8.1 | 47 | 288 | 44 | | 90 | 6 | 70 | 10 | 301 | | 20 | 20 | | low |
| 02/03/86 | 19 | 6.7 | 6.3 | 35 | 497 | | | | | | | | | | | | low |
| 03/05/86 | 14 | 6.2 | 6.9 | 51 | 102 | | | | | | | | | | | | flood |
| 04/04/86 | 21 | 6.9 | 5.4 | 75 | 331 | | | | | | | | | | | | low |
| 05/16/86 | 24 | 6.6 | 5.7 | 67 | 184 | | | | | | | | | | | | mid |
| 06/09/86 | | | | | | | | | | | | | | | | | |
| 07/16/86 | 28 | 6.5 | 3.0 | 31 | 151 | 34 | | 29 | 20 | 130 | 23 | 155 | | 90 | 110 | | mid |
| 08/22/86 | 25 | 6.5 | 4.2 | 32 | 200 | | | | | | | | | | | | low |
| 09/22/86 | 26 | 6.3 | 5.2 | 36 | 126 | | | | | | | | | | | | low |
| 10/27/86 | 19 | 7.0 | | 50 | 158 | 23 | | 44 | 24 | 120 | 34 | 193 | | 130 | 320 | | mid |
| 11/24/86 | 20 | 7.3 | | 82 | 44 | | | | | | | | | | | | flood |
| Mean | 20 | 6.5 | 5.9 | 54 | 194 | 33 | | 47 | 15 | 110 | 24 | 211 | | 102* | 115* | | |
| Std dev | 6.7 | | 1.6 | 23.1 | 104.0 | 11.8 | | 24.4 | 8.6 | 48.3 | 9.1 | 56.5 | | | | | |
| n | 23 | 21 | 20 | 23 | 23 | 5 | 1 | 5 | 5 | 5 | 5 | 5 | 1 | 5 | 5 | | |
| High | 29 | 7.3 | 8.9 | 120 | 497 | 46 | | 90 | 24 | 175 | 34 | 301 | | 940 | 355 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 8 | 6.2 | 3.0 | 24 | 44 | 20 | | 29 | 6 | 55 | 10 | 155 | | 20 | 20 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: LITTLE PINE ISLAND BAYOU SITE # 7 (LPI-7)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/08/84 | 18 | 5.5 | 6.1 | 34 | 125 | | | | | | | | | | | | |
| 12/05/84 | 10 | 6.6 | 8.3 | 114 | 148 | | | | | | | | | | | | mid |
| 01/07/85 | 9 | 6.6 | 9.3 | 47 | 194 | 24 | 51 | 57 | <5 | 125 | 25 | 261 | <10 | 1520 | 360 | | mid |
| 02/19/85 | 15 | 6.3 | 8.3 | 54 | 67 | | | | | | | | | | | | flood |
| 03/19/85 | 17 | 6.3 | 6.4 | 60 | 111 | | | | | | | | | | | | mid |
| 04/24/85 | 24 | 6.7 | 4.5 | 42 | 194 | | | | | | | | | | | | low |
| 05/21/85 | 26 | 7.4 | 8.6 | 28 | 165 | | | | | | | | | | | | mid |
| 06/19/85 | 25 | 7.2 | 5.2 | 38 | 178 | | | | | | | | | | | | mid |
| 07/30/85 | 29 | 6.8 | 5.7 | 18 | 162 | 30 | | 25 | 19 | 40 | 12 | 143 | | 20 | 20 | | low |
| 08/20/85 | 29 | | 7.5 | 14 | 212 | | | | | | | | | | | | low |
| 09/26/85 | 25 | 6.8 | 4.0 | 12 | 240 | | | | | | | | | | | | mid |
| 11/04/85 | 16 | 5.7 | 7.3 | 31 | 121 | | | | | | | | | | | | mid |
| 12/02/85 | 15 | | 6.4 | 46 | 86 | | | | | | | | | | | | mid |
| 01/08/86 | 10 | 6.2 | 6.1 | 51 | 174 | 30 | | 40 | <5 | 100 | 20 | 217 | | 40 | 20 | | mid |
| 02/04/86 | 18 | 7.0 | 8.3 | 37 | 232 | | | | | | | | | | | | mid |
| 03/03/86 | 17 | 6.6 | 8.0 | 62 | 185 | | | | | | | | | | | | mid |
| 04/02/86 | 22 | 6.6 | 8.5 | 28 | 140 | | | | | | | | | | | | low |
| 05/16/86 | 26 | 6.5 | 6.3 | 33 | 122 | | | | | | | | | | | | mid |
| 06/09/86 | 27 | 5.7 | 5.9 | 56 | 25 | | | | | | | | | | | | flood |
| 07/16/86 | 30 | 6.2 | 4.7 | 19 | 127 | 20 | | 18 | 17 | 70 | 24 | 111 | | 60 | 60 | | high |
| 08/22/86 | 26 | 6.4 | 7.9 | 25 | 186 | | | | | | | | | | | | low |
| 09/22/86 | 26 | 6.2 | 4.9 | 18 | 159 | | | | | | | | | | | | low |
| 10/27/86 | 19 | 7.0 | | 44 | 113 | 23 | | 34 | 26 | 150 | 27 | 184 | | 190 | 220 | | mid |
| 11/24/86 | 20 | 7.2 | | 82 | 50 | | | | | | | | | | | | flood |
| Mean | 21 | 6.2 | 6.7 | 41 | 147 | 25 | | 35 | | 97 | 22 | 183 | | 107* | 72* | | |
| Std dev | 6.3 | | 1.5 | 23.1 | 54.8 | 4.4 | | 15.0 | | 43.5 | 5.9 | 59.2 | | | | | |
| n | 24 | 22 | 22 | 24 | 24 | 5 | 1 | 5 | 5 | 5 | 5 | 5 | 1 | 5 | 5 | | |
| High | 30 | 7.4 | 9.3 | 114 | 240 | 30 | | 57 | 26 | 150 | 27 | 261 | | 1520 | 360 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 9 | 5.5 | 4.0 | 12 | 25 | 20 | | 18 | <5 | 40 | 12 | 111 | | 20 | 20 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: MENARD CREEK SITE # 1 (MC-1)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/09/84 | 19 | 6.4 | 7.5 | | 56 | | | | | | | | | | | | |
| 12/05/85 | 9 | 6.3 | 9.3 | 14 | 52 | | | | | | | | | | | | mid |
| 01/07/85 | 9 | 6.5 | 11.2 | 16 | 68 | 10 | 18 | 10 | <5 | 80 | 6 | 96 | <10 | 130 | 40 | | mid |
| 02/20/85 | 14 | 6.6 | 9.4 | 15 | 64 | | | | | | | | | | | | mid |
| 03/18/85 | 18 | 6.6 | 7.8 | 16 | 69 | | | | | | | | | | | | mid |
| 04/23/85 | 22 | 6.7 | 7.0 | 17 | 56 | | | | | | | | | | | | mid |
| 05/22/85 | 23 | 6.5 | 7.3 | 21 | 68 | | | | | | | | | | | | mid |
| 06/17/85 | 26 | 6.5 | 6.8 | 32 | 55 | | | | | | | | | | | | low |
| 07/30/85 | 27 | 6.6 | 7.5 | 10 | 49 | 10 | | 8 | 7 | 70 | 6 | 71 | | 40 | 170 | | low |
| 08/19/85 | 27 | | 7.6 | 32 | 58 | | | | | | | | | | | | low |
| 09/25/85 | 23 | 6.7 | 6.3 | 8 | 52 | | | | | | | | | | | | low |
| 11/06/85 | 14 | 6.5 | 9.0 | 13 | 62 | | | | | | | | | | | | mid |
| 12/04/85 | 12 | | 9.3 | 30 | 52 | | | | | | | | | | | | mid |
| 01/07/86 | 9 | 5.9 | 10.2 | 10 | 55 | 10 | | 10 | 8 | 60 | 4 | 64 | | 130 | 70 | | mid |
| 02/03/86 | 18 | 6.8 | 8.4 | 11 | 63 | | | | | | | | | | | | low |
| 03/04/86 | 12 | 6.3 | 8.9 | 14 | 58 | | | | | | | | | | | | mid |
| 04/04/86 | 19 | 6.5 | 7.5 | 15 | 71 | | | | | | | | | | | | low |
| 05/14/86 | 24 | 6.1 | 6.9 | 36 | 53 | | | | | | | | | | | | mid |
| 06/12/86 | 24 | 6.1 | 7.4 | 20 | 54 | | | | | | | | | | | | high |
| 07/15/86 | 26 | 6.3 | 6.1 | 16 | 57 | 12 | | 9 | 13 | 120 | 8 | 69 | | 100 | 140 | | low |
| 08/08/86 | 25 | 6.3 | 7.4 | 10 | 50 | | | | | | | | | | | | low |
| 09/24/86 | 25 | 6.2 | 8.4 | 23 | 50 | | | | | | | | | | | | mid |
| 10/29/86 | 17 | 7.0 | | 12 | 55 | 10 | | 11 | 11 | 70 | 4 | 71 | | 60 | 300 | | mid |
| 11/27/86 | 13 | 6.6 | | 37 | 44 | | | | | | | | | | | | flood |
| Mean | 19 | 6.4 | 8.1 | 19 | 57 | 10 | | 10 | | 80 | 6 | 74 | | 83* | 115* | | |
| Std dev | 6.2 | | 1.3 | 8.8 | 7.0 | 0.9 | | 1.1 | | 23.5 | 1.7 | 12.5 | | | | | |
| n | 24 | 22 | 22 | 23 | 24 | 5 | 1 | 5 | 5 | 5 | 5 | 5 | 1 | 5 | 5 | | |
| High | 27 | 7.0 | 11.2 | 37 | 71 | 12 | | 11 | 13 | 120 | 8 | 96 | | 130 | 300 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 9 | 5.9 | 6.1 | 8 | 44 | 10 | | 8 | <5 | 60 | 4 | 64 | | 40 | 40 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: MENARD CREEK SITE # 4 (MC-4)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage (USGS) ft | DSX (USGS) cfs | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/09/84 | 20 | 6.5 | 8.2 | 11 | 85 | | | | | | | | | | 9.52 | 80 | mid |
| 12/05/84 | 11 | 6.0 | 9.7 | 20 | 60 | | | | | | | | | | 12.66 | 348 | high |
| 01/07/85 | 10 | 6.4 | 11.3 | 18 | 81 | 10 | 15 | <5 | 100 | 10 | 102 | <10 | 180 | 25 | 10.00 | 110 | mid |
| 02/20/85 | 14 | 6.4 | 10.1 | 17 | 74 | | | | | | | | | | 9.94 | 106 | mid |
| 03/18/85 | 14 | 6.5 | 8.9 | 15 | 81 | | | | | | | | | | 10.50 | 147 | mid |
| 04/22/85 | 23 | 6.6 | 7.4 | 12 | 94 | | | | | | | | | | 8.91 | 49 | low |
| 05/22/85 | 22 | 6.6 | 8.5 | 15 | 85 | | | | | | | | | | 8.31 | 28 | low |
| 06/17/85 | 28 | 6.7 | 7.1 | 13 | 86 | | | | | | | | | | 8.04 | 20 | low |
| 07/30/85 | 27 | 6.4 | 9.1 | 6 | 94 | 12 | 22 | <5 | 40 | 4 | 97 | | 60 | 130 | 8.21 | 25 | low |
| 08/19/85 | 27 | | 8.2 | 7 | 67 | | | | | | | | | | 7.96 | 18 | low |
| 09/25/85 | 25 | 6.8 | 7.5 | 8 | 80 | | | | | | | | | | 7.68 | 12 | low |
| 11/06/85 | 16 | 6.5 | 10.0 | 13 | 72 | | | | | | | | | | 9.20 | 62 | mid |
| 12/04/85 | 11 | | 10.1 | 45 | 59 | | | | | | | | | | 12.36 | 316 | high |
| 01/09/86 | 8 | 6.0 | 10.6 | 9 | 84 | 10 | 20 | 8 | 55 | 2 | 85 | | 70 | 40 | 9.31 | 68 | mid |
| 02/03/86 | 17 | 6.9 | 9.4 | 7 | 94 | | | | | | | | | | 8.91 | 49 | low |
| 03/05/86 | 16 | 6.3 | 9.8 | 11 | 72 | | | | | | | | | | 9.32 | 69 | mid |
| 04/04/86 | 20 | 6.6 | 7.9 | 8 | 100 | | | | | | | | | | 8.53 | 35 | low |
| 05/14/86 | 29 | 6.3 | 8.7 | 35 | 55 | | | | | | | | | | 9.40 | 73 | mid |
| 06/12/86 | 26 | 5.9 | 6.3 | 25 | 50 | | | | | | | | | | 16.84 | 960 | high |
| 07/16/86 | 30 | 6.5 | 7.5 | 25 | 27 | 16 | 25 | <10 | 90 | 47 | 75 | | 130 | 170 | 9.07 | 56 | mid |
| 08/08/86 | 28 | 6.4 | 8.4 | 15 | 111 | | | | | | | | | | 8.21 | 25 | low |
| 09/24/86 | 27 | 6.5 | 6.8 | 24 | 68 | | | | | | | | | | 10.04 | 113 | mid |
| 10/29/86 | 19 | 6.8 | | 11 | 69 | 10 | 17 | 12 | 45 | 10 | 82 | | 140 | 250 | | | low |
| 11/27/86 | 13 | 6.7 | | 34 | 48 | | | | | | | | | | | | flood |
| Mean | 20 | 6.4 | 8.7 | 17 | 75 | 12 | 20 | | 66 | 15 | 88 | | 107* | 89* | | | |
| Std dev | 6.9 | | 1.3 | 10.0 | 18.9 | 2.6 | 4.0 | | 27.2 | 18.5 | 11.1 | | | | | | |
| n | 24 | 22 | 22 | 24 | 24 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 5 | 5 | | | |
| High | 30 | 6.9 | 11.3 | 45 | 111 | 16 | 25 | 12 | 100 | 47 | 102 | | 180 | 250 | | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 8 | 5.9 | 6.3 | 6 | 27 | 10 | 15 | <5 | 40 | 2 | 75 | | 60 | 25 | | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: TURKEY CREEK SITE # 1 (TC-1)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/08/84 | 18 | 6.7 | 8.3 | 12 | 67 | 16 | 19 | 7 | <10 | 50 | 13 | 73 | <10 | 60 | 140 | | |
| 12/07/84 | 9 | 6.6 | 11.3 | 27 | 59 | | | | | | | | | | | | high |
| 01/08/85 | 11 | 6.9 | 13.3 | 10 | 62 | 10 | 18 | 8 | <5 | 45 | 8 | | | 200 | 40 | | mid |
| 02/19/85 | 14 | 6.7 | 10.0 | 13 | 62 | | | | | | | | | | | | mid |
| 03/19/85 | 17 | 6.8 | 8.8 | 14 | 71 | | | | | | | | | | | | mid |
| 04/23/85 | 22 | 6.9 | 9.0 | 12 | 66 | 14 | 18 | 8 | <10 | 40 | 13 | 65 | | 170 | 255 | | mid |
| 05/21/85 | 21 | 6.8 | 7.9 | 31 | 57 | | | | | | | | | | | | mid |
| 06/19/85 | 22 | 6.4 | 7.6 | 33 | 42 | | | | | | | | | | | | high |
| 07/30/85 | 26 | | 7.3 | 10 | 64 | 16 | | 8 | <5 | 40 | 9 | 78 | | 110 | 370 | | low |
| 08/20/85 | 27 | | 7.3 | 10 | 67 | | | | | | | | | | | | low |
| 09/26/85 | 23 | 5.9 | 9.3 | 10 | 60 | | | | | | | | | | | | low |
| 11/04/85 | 15 | 6.6 | 9.4 | 20 | 61 | 11 | | 8 | <5 | 70 | 24 | 73 | | 310 | 200 | | mid |
| 12/02/85 | 14 | | 9.3 | 38 | 53 | | | | | | | | | | | | flood |
| 01/08/86 | 8 | 5.8 | 10.5 | 9 | 25 | 12 | | 8 | 6 | 35 | 9 | 52 | | 220 | 80 | | mid |
| 02/04/86 | 17 | 6.3 | 8.0 | 33 | 35 | | | | | | | | | | | | flood |
| 03/03/86 | 16 | 6.5 | 9.9 | 13 | 66 | | | | | | | | | | | | low |
| 04/01/86 | 18 | 6.5 | 8.1 | 12 | 52 | 16 | | 14 | 6 | 40 | 8 | 75 | | 80 | 50 | | low |
| 05/13/86 | 28 | 6.3 | 7.4 | 22 | 56 | | | | | | | | | | | | mid |
| 06/11/86 | 24 | 5.9 | 6.8 | 45 | 24 | | | | | | | | | | | | flood |
| 07/14/86 | 26 | 6.9 | 6.4 | 13 | 38 | 10 | | 6 | <10 | 90 | 16 | 52 | | | 250 | | mid |
| 07/21/86 | | | | | | | | | | | | | | 80 | 170 | | |
| 08/07/86 | 25 | 6.5 | 7.7 | 10 | 49 | | | | | | | | | | | | low |
| 09/23/86 | 24 | 6.5 | 7.5 | 23 | 53 | | | | | | | | | | | | mid |
| 10/28/86 | 17 | 6.9 | | 20 | 59 | 12 | | 8 | 6 | 60 | 10 | 76 | | 140 | 210 | | mid |
| 11/26/86 | 14 | 7.5 | | 68 | 26 | | | | | | | | | | | | flood |
| Mean | 19 | 6.4 | 8.7 | 21 | 53 | 13 | 18 | 8 | | 52 | 12 | 68 | | 134* | 144* | | |
| Std dev | 5.8 | | 1.6 | 14.4 | 14.1 | 2.5 | 0.6 | 2.2 | | 18.0 | 5.2 | 10.6 | | | | | |
| n | 24 | 21 | 22 | 24 | 24 | 9 | 3 | 9 | 9 | 9 | 9 | 8 | 1 | 9 | 10 | | |
| High | 28 | 7.5 | 13.3 | 68 | 71 | 16 | 19 | 14 | | 90 | 24 | 78 | | 310 | 370 | | |
| Median | | | | | | | | | <10 | | | | | | | | |
| Low | 8 | 5.8 | 6.4 | 9 | 24 | 10 | 18 | 6 | <5 | 35 | 8 | 52 | | 60 | 40 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: TURKEY CREEK SITE # 2 (TC-2)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/08/84 | 18 | 6.8 | 8.3 | 13 | 63 | 16 | 19 | 8 | <10 | 50 | 13 | 68 | <10 | 190 | 105 | | |
| 12/07/84 | 9 | 6.6 | 10.3 | 29 | 58 | | | | | | | | | | | | high |
| 01/08/85 | 10 | 6.7 | 12.3 | 12 | 65 | 16 | 21 | 9 | <5 | 50 | 13 | 63 | 35 | 180 | 35 | | mid |
| 02/19/85 | 14 | 6.6 | 9.9 | 14 | 62 | | | | | | | | | | | | mid |
| 03/19/85 | 17 | 6.7 | 8.6 | 14 | 65 | | | | | | | | | | | | mid |
| 04/23/85 | 22 | 6.4 | 7.7 | 11 | 64 | 14 | 16 | 7 | <10 | 35 | 15 | 64 | | 120 | 240 | | mid |
| 05/21/85 | 21 | 6.4 | 8.6 | 28 | 55 | | | | | | | | | | | | mid |
| 06/19/85 | 22 | 6.7 | 8.6 | 25 | 47 | | | | | | | | | | | | mid |
| 07/30/85 | 26 | | 7.6 | 11 | 64 | 16 | | 9 | <5 | 45 | 10 | 74 | | 300 | 265 | | low |
| 08/20/85 | 28 | | 7.2 | 12 | 67 | | | | | | | | | | | | low |
| 09/26/85 | 24 | 6.0 | 9.0 | 12 | 62 | | | | | | | | | | | | low |
| 11/04/85 | 13 | | 9.1 | 20 | 62 | 10 | | 8 | <5 | 70 | 30 | 76 | | 150 | 160 | | mid |
| 12/02/85 | 14 | | 8.6 | 24 | 53 | | | | | | | | | | | | high |
| 01/08/86 | 9 | 6.1 | 10.3 | 9 | 29 | 14 | | 8 | 7 | 35 | 6 | 58 | | 280 | 10 | | mid |
| 02/04/86 | 17 | 6.3 | 7.8 | 15 | 39 | | | | | | | | | | | | high |
| 03/03/86 | 14 | 6.7 | 9.6 | 14 | 62 | | | | | | | | | | | | low |
| 04/01/86 | 19 | 6.2 | 8.4 | 12 | 33 | 16 | | 10 | 6 | 45 | 9 | 77 | | 200 | 300 | | low |
| 05/13/86 | 25 | 6.3 | 7.6 | 21 | 57 | | | | | | | | | | | | mid |
| 06/11/86 | 24 | 6.1 | 6.4 | 44 | 24 | | | | | | | | | | | | flood |
| 07/14/86 | 27 | 6.2 | 7.7 | 12 | 34 | 12 | | 6 | <10 | 85 | 21 | 52 | | | 160 | | mid |
| 07/21/86 | | | | | | | | | | | | | | 80 | 150 | | |
| 08/07/86 | 26 | 6.4 | 7.9 | 11 | 39 | | | | | | | | | | | | low |
| 09/23/86 | 25 | 6.5 | 8.4 | 15 | 53 | | | | | | | | | | | | mid |
| 10/28/86 | 16 | 6.9 | | 23 | 50 | 10 | | 8 | 7 | 60 | 16 | 68 | | 300 | 140 | | mid |
| Mean | 19 | 6.4 | 8.6 | 17 | 52 | 14 | 19 | 8 | | 53 | 15 | 67 | | 185* | 114* | | |
| Std dev | 6.0 | | 1.3 | 8.3 | 13.1 | 2.5 | 2.5 | 1.2 | | 16.4 | 7.2 | 8.4 | | | | | |
| n | 23 | 19 | 22 | 23 | 23 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 2 | 9 | 10 | | |
| High | 28 | 6.9 | 12.3 | 44 | 67 | 16 | 21 | 10 | | 85 | 30 | 77 | 35 | 300 | 300 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 9 | 6.0 | 6.4 | 9 | 24 | 10 | 16 | 6 | <5 | 35 | 6 | 52 | <10 | 80 | 10 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: TURKEY CREEK SITE # 3 (TC-3)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/08/84 | 20 | 6.6 | 8.2 | 13 | 59 | 16 | 19 | 7 | <10 | 60 | 37 | 64 | <10 | 60 | 50 | | |
| 12/07/84 | 9 | 6.6 | 10.3 | 30 | 58 | | | | | | | | | | | | high |
| 01/08/85 | 9 | 6.5 | 10.3 | | 62 | 10 | 18 | 9 | <5 | 70 | 6 | 84 | <10 | 140 | 40 | | mid |
| 02/19/85 | 14 | 6.5 | 10.8 | 15 | 50 | | | | | | | | | | | | mid |
| 03/19/85 | 17 | 6.4 | 8.6 | 14 | 59 | | | | | | | | | | | | mid |
| 04/23/85 | 22 | 6.7 | 7.6 | 12 | 64 | 14 | 18 | 8 | <10 | 35 | 23 | 52 | | 100 | 290 | | mid |
| 05/21/85 | 21 | 6.3 | 7.8 | 34 | 54 | | | | | | | | | | | | mid |
| 06/19/85 | 22 | 6.8 | 7.7 | 23 | 54 | | | | | | | | | | | | mid |
| 07/30/85 | 26 | | 7.8 | 14 | 59 | 12 | | 9 | <5 | 45 | 28 | 78 | | 120 | 420 | | low |
| 08/20/85 | 28 | | 8.1 | 12 | 66 | | | | | | | | | | | | low |
| 09/26/85 | 19 | 5.6 | 8.6 | 14 | 55 | | | | | | | | | | | | low |
| 11/04/85 | 15 | | 9.0 | 23 | 61 | 10 | | 8 | <5 | 120 | 34 | 80 | | 160 | 150 | | high |
| 12/02/85 | 14 | | 8.2 | 28 | 50 | | | | | | | | | | | | high |
| 01/08/86 | 8 | 6.5 | 10.0 | 8 | 35 | 12 | | 8 | 7 | 35 | 12 | 56 | | 150 | 10 | | mid |
| 02/04/86 | 17 | 6.4 | 8.8 | 29 | 38 | | | | | | | | | | | | high |
| 03/03/86 | 15 | 6.5 | 9.5 | 12 | 55 | | | | | | | | | | | | mid |
| 04/01/86 | 18 | 6.6 | 8.6 | 12 | 60 | 16 | | 10 | 5 | 40 | 7 | 81 | | | 300 | | low |
| 05/13/86 | 30 | 6.3 | 7.7 | 21 | 45 | | | | | | | | | | | | mid |
| 06/11/86 | 25 | 5.8 | 6.3 | 36 | 25 | | | | | | | | | | | | flood |
| 07/14/86 | 27 | 6.3 | 6.5 | 13 | 37 | 12 | | 6 | <10 | 85 | 20 | 50 | | | 130 | | mid |
| 07/21/86 | | | | | | | | | | | | | | 40 | 100 | | |
| 08/07/86 | 26 | 6.4 | 7.5 | 12 | 37 | | | | | | | | | | | | low |
| 09/23/86 | 25 | 6.5 | 7.2 | 16 | 51 | | | | | | | | | | | | mid |
| 10/28/86 | 17 | 6.8 | | 27 | 53 | 10 | | 8 | 7 | 60 | 17 | 69 | | 400 | 420 | | low |
| 11/26/86 | 14 | 7.2 | | 41 | 25 | | | | | | | | | | | | flood |
| Mean | 19 | 6.3 | 8.4 | 20 | 51 | 12 | 18 | 8 | | 61 | 20 | 68 | | 118* | 120* | | |
| Std dev | 6.3 | | 1.2 | 9.3 | 11.8 | 2.4 | 0.6 | 1.2 | | 27.8 | 11.1 | 13.3 | | | | | |
| n | 24 | 20 | 22 | 23 | 24 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 2 | 8 | 10 | | |
| High | 30 | 7.2 | 10.8 | 41 | 66 | 16 | 19 | 10 | | 120 | 37 | 84 | | 400 | 420 | | |
| Median | | | | | | | | | | | | | <10 | | | | |
| Low | 8 | 5.6 | 6.3 | 8 | 25 | 10 | 18 | 6 | <5 | 35 | 6 | 50 | | 40 | 10 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: UPPER NECHES SITE # 1 (UN-1)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Streamflow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/10/85 | 12 | 6.8 | 10.7 | 32 | 109 | 18 | 41 | 22 | 21 | 90 | 21 | 179 | 30 | 70 | 25 | | mid |
| 07/29/85 | 30 | 6.8 | 8.1 | 9 | 149 | 22 | | 21 | 28 | 30 | 15 | 116 | | 20 | 40 | | mid |
| 01/07/86 | 9 | 6.6 | 10.9 | 18 | 103 | 10 | | 22 | 24 | 40 | 18 | 118 | | 10 | 10 | | mid |
| 07/14/86 | 28 | 6.5 | 6.5 | 10 | 103 | 22 | | 20 | 19 | 30 | 25 | 105 | | | 80 | | mid |
| 07/21/86 | | | | | | | | | | | | | | 30 | 30 | | |
| Mean | 20 | 6.7 | 9.1 | 17 | 116 | 18 | | 21 | 23 | 48 | 20 | 130 | | 25* | 30* | | |
| Std dev | 10.8 | | 2.1 | 10.6 | 22.2 | 5.7 | | 1.0 | 3.9 | 28.7 | 4.3 | 33.5 | | | | | |
| n | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 5 | | |
| High | 30 | 6.8 | 10.9 | 32 | 149 | 22 | | 22 | 28 | 90 | 25 | 179 | | 70 | 80 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 9 | 6.5 | 6.5 | 9 | 103 | 10 | | 20 | 19 | 30 | 15 | 105 | | 10 | 10 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: UPPER NECHES SITE # [illegible]

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos/cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/100mL | FS #/100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/08/85 | 11 | 6.9 | 12.3 | 34 | 158 | 18 | 39 | 23 | 21 | 80 | 26 | 167 | <10 | 110 | 20 | | mid |
| 07/29/85 | 30 | 6.8 | 7.5 | 9 | 149 | 20 | | 41 | 26 | 20 | 17 | 121 | | 30 | 20 | | mid |
| 01/06/86 | 10 | 6.3 | 11.2 | 21 | 136 | 14 | | 22 | 26 | 40 | 26 | 118 | | 20 | 10 | | mid |
| Mean | 17 | 6.6 | 10.3 | 21 | 148 | 17 | | 29 | 24 | 47 | 23 | 135 | | 40* | 16* | | |
| Std dev | 11.3 | | 2.5 | 12.5 | 11.1 | 3.1 | | 10.7 | 2.9 | 30.6 | 5.2 | 27.5 | | | | | |
| n | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | | |
| High | 30 | 6.9 | 12.3 | 34 | 158 | 20 | | 41 | 26 | 80 | 26 | 167 | | 110 | 20 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 10 | 6.3 | 7.5 | 9 | 136 | 14 | | 22 | 21 | 20 | 17 | 118 | | 20 | 10 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: VILLAGE CREEK SITE # 3 (VC-3)

| Date | Temp C | pH | DO mg/L | Turb NTU | Cond umhos /cm | Alk mg/L | Hard mg/L | Cl mg/L | SO4 mg/L | Color std. units | TSS mg/L | TDS mg/L | Oil mg/L | FC #/ 100mL | FS #/ 100mL | Stage ft | Stream-flow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/08/84 | 18 | 6.4 | 7.5 | 20 | 74 | 16 | 21 | 9 | <10 | 70 | 14 | 91 | <10 | 70 | 60 | | |
| 12/07/84 | 9 | 6.2 | 11.1 | 16 | 52 | | | | | | | | | | | | flood |
| 01/08/85 | 10 | 6.6 | 10.9 | 18 | 66 | 10 | 21 | 10 | <5 | 80 | 12 | 95 | 40 | 170 | 20 | | mid |
| 02/19/85 | 14 | 6.4 | 9.8 | 16 | 62 | | | | | | | | | | | | mid |
| 03/19/85 | 17 | 6.5 | 8.9 | 15 | 67 | | | | | | | | | | | | mid |
| 04/23/85 | 22 | 6.5 | 7.4 | 16 | 64 | 16 | 18 | 10 | <10 | 45 | 10 | 88 | | 60 | 195 | | mid |
| 05/22/85 | 24 | 6.4 | 8.3 | 22 | 71 | | | | | | | | | | | | mid |
| 06/19/85 | 23 | 6.8 | 7.4 | 18 | 69 | | | | | | | | | | | | mid |
| 07/30/85 | 26 | | 7.8 | 13 | 59 | 14 | | 9 | 6 | 50 | 6 | 72 | | 300 | 1480 | | low |
| 08/20/85 | 29 | | 7.4 | 11 | 70 | | | | | | | | | | | | low |
| 09/26/85 | 24 | 5.7 | 7.8 | 10 | 62 | | | | | | | | | | | | low |
| 11/04/85 | 15 | 6.1 | 8.1 | 22 | 63 | 8 | | 7 | <5 | 180 | 20 | 98 | | 100 | 140 | | high |
| 12/02/85 | 14 | | 8.5 | 20 | 53 | | | | | | | | | | | | high |
| 01/08/86 | 9 | 5.6 | 10.3 | 9 | 40 | 14 | | 10 | 8 | 50 | 10 | 67 | | 40 | 30 | | mid |
| 02/04/86 | 17 | 6.4 | 8.2 | 29 | 53 | | | | | | | | | | | | mid |
| 03/03/86 | 14 | 6.4 | 9.6 | 13 | 62 | | | | | | | | | | | | mid |
| 04/01/86 | 19 | 6.5 | 8.5 | 12 | 62 | 14 | | 12 | 6 | 45 | 6 | 78 | | 100 | 50 | | low |
| 05/13/86 | 30 | 6.3 | 7.3 | 19 | 47 | | | | | | | | | | | | mid |
| 07/15/86 | 29 | 6.3 | 7.1 | 14 | 39 | 14 | | 9 | <10 | 105 | 10 | 73 | | | 130 | | mid |
| 07/21/86 | | | | | | | | | | | | | | 50 | 240 | | |
| 08/07/86 | 26 | 6.6 | 7.5 | 11 | 44 | | | | | | | | | | | | low |
| 09/23/86 | 26 | 6.5 | 7.1 | 15 | 55 | | | | | | | | | | | | mid |
| 10/28/86 | 18 | 6.8 | | 23 | 48 | 8 | | 8 | <5 | 90 | 10 | 75 | | 180 | 260 | | mid |
| Mean | 20 | 6.2 | 8.4 | 16 | 58 | 13 | 20 | 9 | | 79 | 11 | 82 | | 97* | 119* | | |
| Std dev | 6.6 | | 1.2 | 4.9 | 10.1 | 3.2 | 1.7 | 1.4 | | 43.4 | 4.3 | 11.3 | | | | | |
| n | 22 | 19 | 21 | 22 | 22 | 9 | 3 | 9 | 9 | 9 | 9 | 9 | 2 | 9 | 10 | | |
| High | 30 | 6.8 | 11.1 | 29 | 74 | 16 | 21 | 12 | | 180 | 20 | 98 | 40 | 300 | 1480 | | |
| Median | | | | | | | | | | | | | | | | | |
| Low | 9 | 5.6 | 7.1 | 9 | 39 | 8 | 18 | 7 | <5 | 45 | 6 | 67 | <10 | 40 | 20 | | |

Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

# APPENDIX B

## US Geological Survey Water Quality Monitoring Data for Stations in the Vicinity of Big Thicket National Preserve November 1984 - November 1986

STATION NAME: USGS MENARD CREEK NEAR RYE, TX 08066300

| Date | Temp C | Cond umhos | Na (diss) mg/L | Ca (diss) mg/L | Mg (diss) mg/L | K (diss) mg/L | Alk (tot) mg/L | Cl (diss) mg/L | SO4 (diss) mg/L | F (diss) mg/L | Hard (tot) mg/L | Si (diss) mg/L | TDS mg/L | Discharge cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/29/84 | | 66 | 7 | 5 | 1.2 | 1.0 | 11 | 11 | 6 | <0.1 | 17 | 14 | 51 | 73 |
| 01/18/85 | 10 | 79 | 9 | 5 | 1.2 | 1.0 | 7 | 16 | 8 | <0.1 | 17 | 13 | 57 | 163 |
| 02/19/85 | 13 | 77 | 9 | 5 | 1.1 | 0.8 | 10 | 15 | 5 | <0.1 | 16 | 11 | 52 | 112 |
| 04/01/85 | 19 | 77 | 8 | 5 | 1.4 | 1.2 | 12 | 15 | 6 | <0.1 | 19 | 12 | 56 | 182 |
| 05/21/85 | | 94 | 11 | 6 | 1.3 | 1.3 | 11 | 19 | 8 | <0.1 | 19 | 12 | 65 | 34 |
| 07/01/85 | | 69 | 7 | 5 | 1.2 | 1.6 | 12 | 12 | 6 | <0.1 | 16 | 15 | 54 | 14 |
| 08/20/85 | 28 | 63 | 7 | 4 | 1.1 | 1.0 | 10 | 11 | 7 | <0.1 | 15 | 13 | 50 | 16 |
| 09/25/85 | 25 | 76 | 9 | 5 | 1.2 | 1.2 | 10 | 15 | 5 | <0.1 | 17 | 15 | 58 | 12 |
| 11/06/85 | 15 | 76 | 7 | 5 | 1.4 | 3.1 | 7 | 14 | 10 | <0.1 | 18 | 14 | 59 | 61 |
| 12/16/85 | 17 | 44 | 4 | 3 | 0.9 | 1.2 | 5 | 7 | 6 | <0.1 | 12 | 8 | 32 | 588 |
| 01/28/86 | 11 | 89 | 10 | 5 | 1.3 | 0.8 | 10 | 18 | 5 | <0.1 | 17 | 13 | 58 | 42 |
| 03/19/86 | 19 | 79 | 9 | 5 | 1.3 | 1.1 | 11 | 15 | 6 | <0.1 | 18 | 12 | 56 | 44 |
| 05/07/86 | 21 | 81 | 9 | 5 | 1.2 | 1.1 | 8 | 12 | 13 | <0.1 | 17 | 10 | 56 | 75 |
| 06/23/86 | 27 | 68 | 7 | 5 | 1.3 | 1.1 | 10 | 10 | 12 | 0.2 | 18 | 11 | 53 | 77 |
| 08/11/86 | 27 | 136 | 16 | 7 | 1.5 | 1.0 | 13 | 30 | 6 | <0.1 | 23 | 13 | 82 | 25 |
| 09/29/86 | 26 | 99 | 11 | 6 | 1.4 | 1.2 | 11 | 20 | 13 | <0.1 | 20 | 15 | 74 | 60 |
| 11/17/86 | 17 | 85 | 9 | 5 | 1.3 | 1.3 | 9 | 14 | 11 | <0.1 | 17 | 14 | 60 | 41 |
| Mean | 20 | 80 | 9 | 5 | 1.3 | 1.2 | 10 | 15 | 8 | | 17 | 13 | 57 | 95 |
| Std dev | 6.2 | 19.2 | 2.5 | 0.8 | 0.1 | 0.5 | 2.1 | 5.1 | 2.9 | | 2.3 | 1.9 | 10.5 | 136.0 |
| n | 14 | 17 | 17 | 17 | 17.0 | 17.0 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| High | 28 | 136 | 16 | 7 | 1.5 | 3.1 | 13 | 30 | 13 | 0.2 | 23 | 15 | 82 | 588 |
| Low | 10 | 44 | 4 | 3 | 0.9 | 0.8 | 5 | 7 | 5 | <0.1 | 12 | 8 | 32 | 12 |

Sodium reported as Na
Calcium reported as Ca
Magnesium reported as Mg
Potassium reported as K
Alkalinity reported as CaCO3
Chloride reported as Cl
Sulfate reported as SO4
Fluoride reported as F
Hardness reported as CaCO3
Silica reported as SiO2

Note: This station is the same as MC-4

STATION NAME: USGS PINE ISLAND BAYOU NEAR SOUR LAKE, TX 08041700

| Date | Temp C | Cond umhos | Na (diss) mg/L | Ca (diss) mg/L | Mg (diss) mg/L | K (diss) mg/L | Alk (tot) mg/L | Cl (diss) mg/L | SO4 (diss) mg/L | F (diss) mg/L | Hard (tot) mg/L | Si (diss) mg/L | TDS mg/L | Discharge cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 02/08/85 | 7 | 151 | 18 | 10 | 1.7 | 1.8 | 16 | 29 | 13 | <0.1 | 32 | 6 | 89 | 338 |
| 03/18/85 | 17 | 138 | 15 | 12 | 1.9 | 1.7 | 26 | 22 | 15 | <0.1 | 38 | 5 | 88 | 556 |
| 05/13/85 | 26 | 420 | 53 | 24 | 4.0 | 3.1 | 43 | 91 | 19 | 0.2 | 76 | 8 | 230 | 14 |
| 07/25/85 | 28 | 164 | 17 | 12 | 2.5 | 1.6 | 36 | 18 | 17 | 0.1 | 40 | 8 | 98 | 39 |
| 09/10/85 | 27 | 199 | 23 | 13 | 2.5 | 4.4 | 36 | 32 | 30 | 0.1 | 43 | 8 | 130 | 23 |
| 10/31/85 | 18 | 81 | 8 | 6 | 1.2 | 2.0 | 15 | 10 | 12 | <0.1 | 20 | 7 | 55 | 2050 |
| 01/15/86 | 9 | 326 | 40 | 19 | 2.9 | 2.2 | 36 | 73 | 13 | <0.1 | 59 | 7 | 180 | 42 |
| 02/20/86 | 21 | 158 | 17 | 11 | 1.8 | 2.1 | 18 | 31 | 13 | 0.1 | 35 | 5 | 92 | 106 |
| 04/02/86 | 21 | 337 | 38 | 21 | 3.7 | 2.8 | 39 | 68 | 18 | 0.2 | 68 | 7 | 180 | 15 |
| 05/09/86 | 24 | 131 | 12 | 9 | 1.6 | 2.3 | 18 | 17 | 15 | <0.1 | 30 | 6 . | 74 | 335 |
| 10/01/86 | 27 | 152 | 15 | 12 | 1.9 | 2.7 | 25 | 25 | 12 | <0.1 | 38 | 8 | 92 | 79 |
| Mean | 20 | 205 | 23 | 14 | 2.3 | 2.4 | 28 | 38 | 16 | | 44 | 7 | 119 | 327 |
| Std dev | 7.2 | 106.4 | 14.1 | 5.5 | 0.9 | 0.8 | 10.3 | 26.7 | 5.2 | | 17.1 | 1.2 | 54.6 | 598.6 |
| n | 11 | 11 | 11 | 11 | 11.0 | 11.0 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| High | 28 | 420 | 53 | 24 | 4.0 | 4.4 | 43 | 91 | 30 | 0.2 | 76 | 8 | 230 | 2050 |
| Low | 7 | 81 | 8 | 6 | 1.2 | 1.6 | 15 | 10 | 12 | <0.1 | 20 | 5 | 55 | 14 |

Sodium reported as Na
Calcium reported as Ca
Magnesium reported as Mg
Potassium reported as K
Alkalinity reported as CaCO3

Chloride reported as Cl
Sulfate reported as SO4
Fluoride reported as F
Hardness reported as CaCO3
Silica reported as SiO2

STATION NAME: USGS VILLAGE CREEK NEAR KOUNTZ, TX 08041500

| Date | Temp C | Cond umhos | Na (diss) mg/L | Ca (diss) mg/L | Mg (diss) mg/L | K (diss) mg/L | Alk (tot) mg/L | Cl (diss) mg/L | SO4 (diss) mg/L | F (diss) mg/L | Hard (tot) mg/L | Si (diss) mg/L | TDS mg/L | Discharge cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/20/84 | 15 | 53 | 5 | 5 | 1.0 | 1.4 | 7 | 9 | 10 | <0.1 | 16 | 11 | 47 | 854 |
| 02/07/85 | 7 | 77 | 10 | 4 | 1.1 | 1.2 | 7 | 16 | 7 | <0.1 | 16 | 13 | 56 | 929 |
| 03/19/85 | 17 | 76 | 9 | 5 | 1.2 | 1.0 | 11 | 14 | 5 | <0.1 | 17 | 12 | 54 | 812 |
| 05/15/85 | 23 | 97 | 12 | 6 | 1.3 | 1.1 | 13 | 21 | 6 | <0.1 | 20 | 14 | 69 | 234 |
| 07/02/85 | 28 | 95 | 11 | 6 | 1.3 | 1.7 | 10 | 18 | 10 | <0.1 | 20 | 13 | 67 | 125 |
| 07/24/85 | 29 | 65 | 8 | 4 | 1.0 | 1.1 | 8 | 12 | 9 | <0.1 | 14 | 10 | 49 | 212 |
| 09/06/85 | 27 | 99 | 11 | 6 | 1.2 | 1.4 | 13 | 19 | 8 | <0.1 | 20 | 12 | 67 | 61 |
| Mean | 21 | 80 | 9 | 5 | 1.2 | 1.3 | 10 | 16 | 8 | | 18 | 12 | 58 | 461 |
| Std dev | 8.2 | 17.6 | 2.4 | 0.9 | 0.1 | 0.2 | 2.6 | 4.2 | 2.0 | | 2.4 | 1.3 | 9.2 | 383.6 |
| n | 7 | 7 | 7 | 7 | 7.0 | 7.0 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| High | 29 | 99 | 12 | 6 | 1.3 | 1.7 | 13 | 21 | 10 | 0.2 | 20 | 14 | 69 | 929 |
| Low | 7 | 53 | 5 | 4 | 1.0 | 1.0 | 7 | 9 | 5 | <0.1 | 14 | 10 | 47 | 61 |

Sodium reported as Na
Calcium reported as Ca
Magnesium reported as Mg
Potassium reported as K
Alkalinity reported as CaCO3

Chloride reported as Cl
Sulfate reported as SO4
Fluoride reported as F
Hardness reported as CaCO3
Silica reported as SiO2

STATION NAME: USGS NECHES RIVER AT EVADALE, TX 08041000 (pg 1)

| Date | Temp C | Cond umhos | Na (diss) mg/L | Ca (diss) mg/L | Mg (diss) mg/L | K (diss) mg/L | Alk (tot) mg/L | Cl (diss) mg/L | SO4 (diss) mg/L | F (diss) mg/L | Hard (tot) mg/L | Si (diss) mg/L | TDS mg/L | Discharge cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/05/84 | 21 | 109 | 11 | 7 | 2.1 | 3.1 | 15 | 12 | 23 | <0.1 | 26 | 11 | 79 | 4150 |
| 01/29/85 | 8 | 158 | 18 | 9 | 3.0 | 2.6 | 14 | 21 | 30 | <0.1 | 34 | 15 | 110 | 6620 |
| 03/27/85 | 19 | 151 | 16 | 8 | 3.0 | 2.9 | 14 | 20 | 23 | <0.1 | 32 | 9 | 90 | 10400 |
| 06/11/85 | 30 | 173 | 19 | 8 | 3.5 | 3.0 | 16 | 27 | 25 | <0.1 | 35 | 10 | 110 | 3280 |
| 07/22/85 | 30 | 154 | 17 | 7 | 3.2 | 2.9 | 18 | 22 | 22 | 0.1 | 31 | 9 | 94 | 3610 |
| 09/09/85 | 30 | 165 | 19 | 8 | 3.6 | 3.1 | 20 | 22 | 24 | 0.1 | 34 | 9 | 100 | 2730 |
| 11/19/85 | 22 | 126 | 13 | 7 | 2.4 | 3.2 | 12 | 16 | 26 | <0.1 | 27 | 14 | 89 | 2910 |
| 01/06/86 | 11 | 151 | 15 | 7 | 2.9 | 3.4 | 10 | 26 | 18 | <0.1 | 28 | 12 | 89 | 5020 |
| 02/19/86 | 17 | 162 | 18 | 8 | 3.4 | 2.8 | 17 | 22 | 25 | <0.1 | 33 | 10 | 99 | 11300 |
| 03/31/86 | 21 | 170 | 19 | 8 | 3.6 | 3.0 | 21 | 21 | 25 | <0.1 | 35 | 10 | 100 | 2420 |
| 05/13/86 | 26 | 148 | 14 | 7 | 2.9 | 3.7 | 18 | 15 | 24 | <0.1 | 29 | 8 | 84 | 6790 |
| 08/25/86 | 30 | 172 | 17 | 8 | 3.4 | 2.8 | 25 | 18 | 18 | 0.1 | 34 | 10 | 91 | 2750 |
| Mean | 22 | 153 | 16 | 8 | 3.1 | 3.0 | 17 | 20 | 24 | | 32 | 11 | 95 | 5165 |
| Std dev | 7.5 | 19.1 | 2.6 | 0.7 | 0.5 | 0.3 | 4.1 | 4.3 | 3.3 | | 3.2 | 2.1 | 9.6 | 3033.2 |
| n | 12 | 12 | 12 | 12 | 12.0 | 12.0 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| High | 30 | 173 | 19 | 9 | 3.6 | 3.7 | 25 | 27 | 30 | 0.1 | 35 | 15 | 110 | 11300 |
| Low | 8 | 109 | 11 | 7 | 2.1 | 2.6 | 10 | 12 | 18 | <0.1 | 26 | 8 | 79 | 2420 |

Sodium reported as Na
Calcium reported as Ca
Magnesium reported as Mg
Potassium reported as K
Alkalinity reported as CaCO3

Chloride reported as Cl
Sulfate reported as SO4
Fluoride reported as F
Hardness reported as CaCO3
Silica reported as SiO2

STATION NAME: USGS NECHES RIVER AT EVADALE, TX  08041000  (pg 2)

| Date | pH | DO mg/L | DO % Sat | BOD5 mg/L | Turb NTU | Susp Sed mg/L | FC #/ 100mL | FS #/ 100mL | NH3-N (diss) mg/L | NH3-N (tot) mg/L | NO2-N (diss) mg/L | NO2 + NO3-N (diss) mg/L | ORG-N (tot) mg/L | PO4-P (diss) mg/L | PO4-P (tot) mg/\l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/05/84 | 6.4 | 10.2 | 117 | 1.6 | 34 | 48 | 44 | 26 | 0.04 | | | <0.1 | | 0.02 | 0.07 |
| 01/29/85 | 6.6 | 12.4 | 104 | 1.9 | 40 | 147 | 270 | 150 | 0.03 | | | <0.1 | | 0.02 | 0.07 |
| 03/27/85 | 6.7 | 8.5 | 90 | 2.1 | 17 | 17 | 28 | 120 | 0.03 | | | <0.1 | | 0.02 | 0.05 |
| 06/11/85 | 6.9 | 7.7 | 101 | 1.5 | 29 | 59 | 46 | 240 | 0.06 | | | <0.1 | | 0.03 | 0.06 |
| 07/22/85 | 6.4 | 8.8 | 112 | 1.8 | 23 | 26 | 60 | 250 | 0.05 | | | <0.1 | | 0.02 | <0.01 |
| 09/09/85 | 7.2 | 7.5 | 99 | 1.2 | 17 | 15 | 36 | 150 | 0.05 | | | <0.1 | | 0.02 | 0.03 |
| 11/19/85 | 6.6 | 8.8 | 100 | 1.6 | 39 | 86 | 88 | 110 | 0.03 | 0.08 | <0.01 | 0.11 | 0.72 | 0.02 | 0.06 |
| 01/06/86 | 6.9 | 10.6 | 94 | 1.1 | 27 | 18 | 46 | 14 | 0.01 | 0.02 | <0.01 | <0.1 | 0.68 | | <0.01 |
| 02/19/86 | 7.1 | 11.0 | 113 | 1.1 | 26 | 20 | 170 | 130 | 0.03 | 0.02 | <0.01 | <0.1 | 0.48 | 0.02 | 0.05 |
| 03/31/86 | 6.5 | 10.0 | 111 | 2.1 | 28 | 25 | 2 | 120 | 0.02 | 0.01 | <0.01 | <0.1 | 0.49 | 0.03 | 0.05 |
| 05/13/86 | 6.2 | 7.5 | 91 | 1.6 | 32 | 47 | 32 | 88 | 0.05 | 0.05 | <0.01 | <0.1 | 0.75 | 0.03 | 0.07 |
| 08/25/86 | 7.8 | 8.5 | 111 | 1.2 | 15 | 41 | 88 | 120 | 0.02 | 0.04 | <0.01 | <0.1 | 0.26 | 0.02 | 0.04 |
| Mean | 6.6 | 9.3 | 104 | 1.6 | 27 | 46 | 47* | 101* | 0.04 | 0.04 | | | 0.56 | 0.02 | |
| Std dev | | 1.5 | 9.2 | 0.4 | 8.3 | 38.3 | | | 0.02 | 0.03 | | | 0.19 | 0.00 | |
| n | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 6 | 6 | 12 | 6 | 11 | 12 |
| High | 7.8 | 12.4 | 117 | 2.1 | 40 | 147 | 270 | 250 | 0.06 | 0.08 | | 0.11 | 0.75 | 0.03 | 0.07 |
| Median | | | | | | | | | | | <0.1 | | | | |
| Low | 6.2 | 7.5 | 90 | 1.1 | 15 | 15 | 2 | 14 | 0.01 | 0.01 | | <0.1 | 0.26 | 0.02 | <0.01 |

Ammonia (NH4-N) reported as N
Nitrite (NO2-N) reported as N
Nitrate (NO3-N) reported as N
Organic nitrogen (ORG-N) reported as N
Phosphorus (PO4-P) reported as P

Note:
Asterisk (*) denotes geometric mean for bacterial analysis
Mean pH was determined from the mean hydrogen ion concentration reconverted to pH

STATION NAME: USGS NECHES RIVER AT EVADALE, TX 08041000 (pg 3)

| Date | As (diss) ug/L | Ba (diss) ug/L | Cd (diss) ug/L | Cr (diss) ug/L | Co (diss) ug/L | Cu (diss) ug/L | Fe (diss) ug/L | Pb (diss) ug/L | Mn (diss) ug/L | Hg (diss) ug/L | Mo (diss) ug/L | Ni (diss) ug/L | Se (diss) ug/L | Ag (diss) ug/L | Sr (diss) ug/L | Zn (diss) ug/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/05/84 | 1 | 46 | 2 | <1 | <3 | 4 | 480 | 11 | 23 | <0.1 | <10 | 3 | <1 | <1 | 70 | 33 |
| 01/29/85 | <1 | 51 | <1 | 1 | <3 | 3 | 450 | 1 | 79 | <0.1 | <10 | 2 | <1 | <1 | 91 | 16 |
| 03/27/85 | | | | | | | | | | | | | | | | |
| 06/11/85 | 1 | 45 | <1 | <1 | <3 | 3 | 220 | 5 | 8 | <0.1 | 10 | 4 | <1 | <1 | 96 | 17 |
| 07/22/85 | | | | | | | | | | | | | | | | |
| 09/09/85 | <1 | 40 | <1 | <1 | <3 | 2 | 28 | 1 | 3 | 0.1 | <10 | 1 | <1 | <1 | 98 | <3 |
| 11/19/85 | 1 | 40 | <1 | <1 | <3 | 3 | 420 | <1 | 13 | 0.2 | <10 | 2 | <1 | <1 | 70 | 47 |
| 01/06/86 | | | | | | | | | | | | | | | | |
| 02/19/86 | <1 | 48 | <1 | <1 | <3 | 1 | 100 | 1 | 22 | <0.1 | <10 | 8 | <1 | <1 | 97 | 19 |
| 03/31/86 | | | | | | | | | | | | | | | | |
| 05/13/86 | | | | | | | | | | | | | | | | |
| 08/25/86 | <1 | 47 | 3 | <1 | <3 | 2 | 36 | <5 | 3 | <0.1 | <10 | 3 | <1 | <1 | 100 | 24 |
| Mean | | 45 | | | | 3 | 248 | | 22 | | | 3 | | | 89 | |
| Std dev | | 4.1 | | | | 1.0 | 200.1 | | 26.6 | | | 2.3 | | | 13.2 | |
| n | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| High | 1 | 51 | 3 | 1 | | 4 | 480 | 11 | 79 | 0.2 | 10 | 8 | | | 100 | 47 |
| Median | <1 | | <1 | <1 | <3 | | | 1 | | <0.1 | <10 | | <1 | <1 | | 24 |
| Low | <1 | 40 | <1 | <1 | | 1 | 28 | <1 | 3 | <0.1 | <10 | 1 | | | 70 | <3 |